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Dr. Dobb's Journal

#92 JUNE 1984

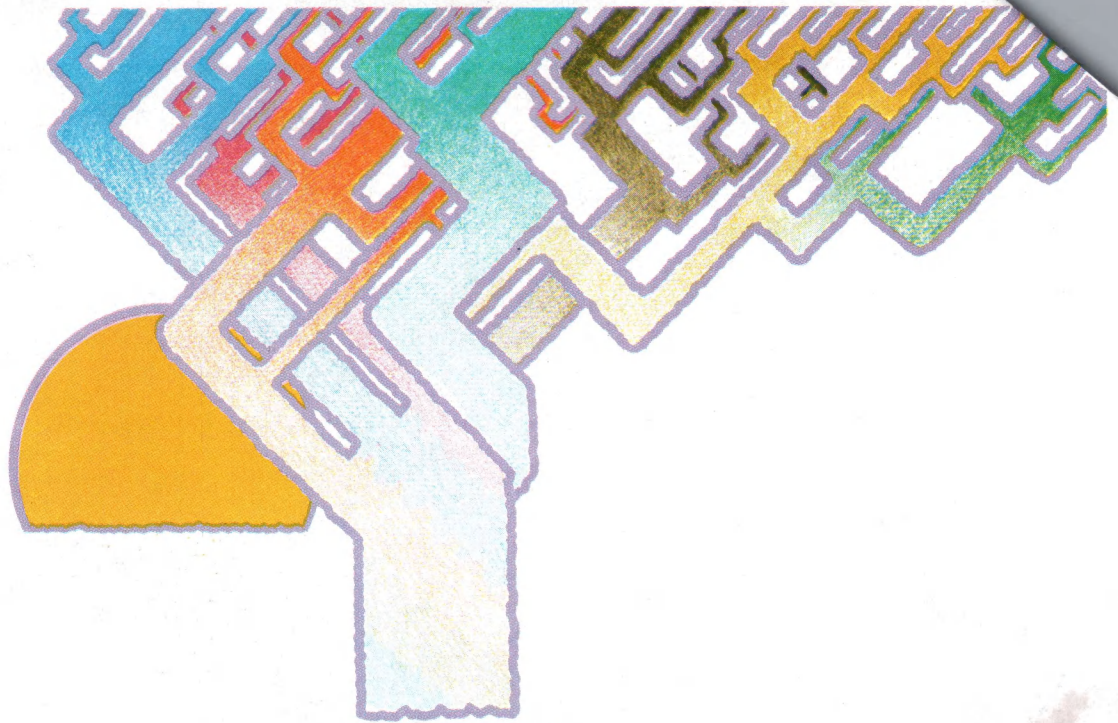
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Dr. Dobb's Journal (USPS 307690) is published monthly by M&T Publishing, Inc., 2464 Embarcadero Way, Palo Alto, CA 94303, (415) 424-0600. Second class postage paid at Palo Alto and at additional entry points. Address correction requested. Postmaster: Send Form 3579 to *Dr. Dobb's Journal*, 2464 Embarcadero Way, Palo Alto, CA 94303. ISSN 0278-6508

Subscription Rates: \$25 per year within the United States, \$44 for first class to Canada and Mexico, \$62 for airmail to other countries. Payment must be in U.S. Dollars, drawn on a U.S. Bank.

Contributing Subscribers: *Christine Bell, W. D. Rausch, DeWitt S. Brown, Burks A. Smith, Robert C. Luckey, Transdata Corp., Mark Ketter, Friden Mailing Equipment, Frank Lawyer, Rodney Black, Kenneth Drexler, Real Paquin, Ed Malin, John Saylor Jr., Ted A. Reuss III, InfoWorld, Stan Veit, Western Material Control, S. P. Kennedy, John Hatch, Richard Jorgensen, John Boak, Bill Spees, R. B. Sutton. Lifetime Subscribers: Michael S. Zick, F. Kirk.*

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In This Issue

Over the next few months you will be seeing some cosmetic changes in *Dr. Dobb's*. Some will be intended to enhance newsstand visibility, some to enhance general readability, some to increase contact or involvement with the readership. You may have noticed when you picked up this issue that the logo is slightly different, as is the descriptor line above the title. In future issues you will see some variation in format for various sections of the magazine, and our conversion in July to a new typesetting system will result in greater readability as well. This issue we have added the section you are presently reading.

With the Editorial page being exclusively devoted to essays each month, we found that we needed some space in which to let you know about things of importance regarding the magazine. This is that space. You will find highlights of the current issue and coming topics, announcements of events or other items of interest, acknowledgments of special contributions to the magazine, or other things we consider noteworthy.

Since we are still settling in, we will postpone details on our growing number of projects, including the bulletin board to which we have alluded, until they progress a bit further. One project that is in full swing, however, is our Fifth Generation Programming Competition. If you did not notice our full-page announcement last month, take a look at page 81 this month for details. In addition, our efforts to improve services should be evident from the growth of the masthead. Many of the new names you will find there are folks who will be making sure that *DDJ* is more available on the newsstands and that subscriptions are serviced better.

The contents page (facing) should give you a good overview of what we have for you this month. During the next few months you can look forward to continued coverage of C and Small C, including a preprocessor for the Small C compiler. Forth will remain an active topic, with our annual Forth issue scheduled for September. Some other items to watch for include an infinite key cryptography system, discussion of Resident System Extensions under CP/M Plus, and some articles on mathematical computation.

Reynold Wiggins

This Month's Referees

Dr. Dobb's Journal regularly draws on the expertise of a Board of Referees for technical evaluation of material submitted for publication. In addition to their remarks to the editors concerning accuracy and relevance of manuscripts, the referees often provide constructive comments for authors regarding clarity or completeness.

The board includes nearly fifty experts from diverse areas of the computer industry and the academic community. Because of space considerations, we can print a list of the entire board only a few times each year. Monthly, however, we do print the names of the referees who contributed their insights on material in that particular issue. Your humble editors, who bear the burden of choosing how material ultimately appears, are grateful for the beneficial insights we receive.

The referees who contributed to this month's issue are:

David E. Cortesi, Contributing Editor, *DDJ*

Kim Harris, Forthright Enterprises

J. E. Hendrix, Office of Computing & Information Services, University of Mississippi

William Ragsdale, President, Dorado Systems

Dr. Dobb's Journal

June 1984
Volume 9, Issue 6

CONTENTS

ARTICLES

14 CP/M on the Commodore 64 — Including Two BIOS Modifications

by *Walter G. Piotrowski*

This article presents a brief overview of CP/M on the Commodore 64 along with details of how to patch the BIOS to accommodate two 1541 disk units and/or an RS-232 printer (Reader Ballot No. 192)

28 dBase II Programming Techniques

by *Gene Head*

Departing from last month's discussion of dBase quirks, the author presents a machine-language sub-routine designed for mailing list applications. The technique allows one to partially verify Zip codes and validate states. (Reader Ballot No. 193)

32 First Chinese Forth: A Double-Headed Approach

by *Timothy Huang*

Challenged by the task of providing a computer language which could be used by Chinese-speaking people, this author chose Forth as the most logical computer language to implement in Chinese. (Reader Ballot No. 194)

40 cc — A Driver for a Small-C Programming System

by *Axel T. Schreiner*

Patterned after the Unix *cc* command, this utility accepts options and file specifications, then uses CP/M's SUBMIT facility to arrange the proper amount of preprocessing, compiling assembly, and loading. (Reader Ballot No. 195)

56 A New Library For Small C (Part II)

by *James Hendrix and Ernest Payne*

The listing of the new library for Small C v.2, begun last month, concludes this issue with the second half of the user functions. (Reader Ballot No. 196)

70 Comments on Sixth Generation Computers

by *Michael J. Doherty*

The dialogue continues: Doherty responds to Grigonis' essay last month on sixth generation computers. (Reader Ballot No. 197)

DEPARTMENTS

9 Editorial

10 Letters

12 Dr. Dobb's Clinic

Quasi-Disk; Fooling RMAC; DIR Not-Quite-So-Full; Without Fear or Good Taste (Reader Ballot No. 191)

74 Software Reviews

Turbo Pascal

82 16-Bit Software Toolbox

Professional Basic; The Filepath Utility; Beating the Laws of Thermodynamics; Floating-Point Benchmarks; More on the Microsoft 8086 Assembler; A Toolbox Installment (word_to_hex and byte_to_hex) (Reader Ballot No. 198)

86 C/Unix Programmer's Notebook

8086 memory models; Long pointer package for C compilers (Reader Ballot No. 199)

108 Of Interest

(Reader Ballot No. 200)

110 Advertiser Index



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About those dragons.

Dr. Dobb's Journal prides itself on providing useful tools and information for advanced programmers. Last month we ranged beyond the fields we know and published an article on "sixth generation computers," whose author explored the implications of applying bizarre twists of quantum physics to computer design. The discussion of faster-than-light particles with imaginary rest mass will probably never help anyone write a better spreadsheet program or word processor; it frankly bordered on fantasy. Here's why we published it.

China story, version 1.0: China, until the twentieth century, was largely isolated from Western culture. Homage to traditions had kept some strange practices (acupuncture, footbinding) in force while modern science developed in the West. When, in the twentieth century a new generation of Chinese, unwilling to suffer longer the mindbinding of tradition, brought in Western science, the intellectual conquest was swift. Science punctured the fragile structure of ancient traditions, and China joined the twentieth century. Then in 1954 the communists overturned all these advances, exiled the intellectuals to farms and brought back superstition and ignorance as state policy.

China story, version 2.0: China, the oldest civilization on the planet, had a rich structure of tradition. In the twentieth century, overawed by Western technological advances, young Chinese revisionists built a power structure of intellectuals modeled along alien Western lines, and trampled traditional Chinese values. In 1954, the government took action to redress the balance and protect the country's traditions from Western erosion.

Which China story is the truth? Probably neither, but both have been purveyed as truth, and the disparity between the two versions underscores the danger of complacency about one's worldview. Western science is itself a tradition, with its blind spots and unquestioned dogma. It isn't always the best tradition. It is now apparent that some traditional Chinese medical practices work better than their Western counterparts. Unfortunately the blinders of the Western scientific tradition insured that only those scientists who were willing to look into something they *knew* couldn't work were in a position to learn this fact. Those who entertained notions that bordered on fantasy are the ones who learned something new.

It's that way with programming, too.

DDJ isn't interested in *just* helping programmers write better spreadsheets and word processors (although we do that.) Programming at its best is a creative activity, and requires that willingness to entertain ideas that can't possibly work. Programming at its best is what *DDJ* is about. So we'll range beyond the fields we know, and sometimes we may trip. This time, apparently, we didn't. As of this writing, our mail is running overwhelmingly in favor of the sixth generation article.

This month we set forth to China, and embark on a different kind of fantasy, with Timothy Huang's article on Chinese Forth. *DDJ* has always championed the cause of putting computer power into the hands of the largest number of people, and placing Forth in the language of a large fraction of Earth's inhabitants is surely a step in that direction. It is of course a fantasy to think that the efforts described in this article will have any significant effect on U.S.-Chinese relations or on our survival on the planet. Isn't it?

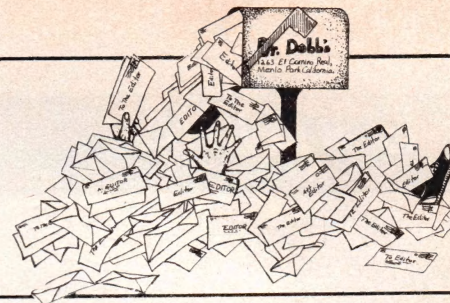
Oh yes, the dragons.

This month's cover depicts two dragons, one Western, one Chinese, sharing technology. (The Western dragon is the fat one.) It nicely illustrates our Chinese Forth article. But the dragon is *DDJ*'s symbol, too; one the magazine has, since its first issue, used as a reminder not to be tied to the fields we know. Personal computers are changing the world, and only those who are willing to poke the dragon will find the jewels clinging to its belly.

DDJ has been tickling the dragon for eight years, and sharing the jewels. We think we'll keep right on doing it.

Michael Swaine

Michael Swaine



The editorial response card is a great way to talk to us, but don't forget that Dr. Dobb's Journal also welcomes letters to the editor as a forum for ideas, innovations, irascibility and even idiosyncrasies. Some letters may be edited for clarity and brevity. The Doctor likes hearing from you — keep on writing.

On Soul of CP/M

Dear DDJ:

I get the feeling that the review of *Soul of CP/M*, Waite & Lafore, was from the viewpoint of an experienced assembly language programmer looking backward. Granted, the number of editorial errors was attackable, but the manner in which the material was presented was tremendous for the target readership.

I've read (or started to read) a good number of CP/M assembly language books. Nealy all of them take the approach of presenting the BDOS calls at the front, numerous multi-page program samples with unintelligible labels and explanations, some cryptic references to the perfect BIOS, and an appendix with the 8080/Z80 instruction set.

Waite & Lafore feed the material in chewable bytes (pun intended) so the reader doesn't need a brain with a Z80 and 64K of permanent memory to comprehend and retain it. No, it is certainly not a complete text, but at least now all those other books make sense to me.

If they can eliminate the remaining editorial errors in the second printing, they have a winner.

Doug Hurst
6808 Estrella Avenue
29 Palms, CA 92277

Even Better Preprocessing

Dear Doctor:

Although this journal may not have many clients — excuse me, readers — who do (or will admit to doing) much programming in BASIC, there must be others like myself who for one reason or another are constrained to use this language (but only during working hours, I protest). All BASIC users owe a debt of gratitude to N. C. Shammass for the NBASIC preprocessor presented in your January issue. This tremendously useful routine has mitigated some of the most serious drawbacks of interpreted BASIC.

There are, however, a couple of improvements that users might wish to make.

The first of these is to make the CASE statement accept strings as expressions, a relatively simple change that requires adding or modifying only four or five lines. The second is a major rearrangement of the program so that CALL statements are processed before the CASE-OF structures. The reason for this is that processing of the CASE-OF commands puts a GOTO on the end of the last line of each group of expressions. CALL statements are resolved into GOSUBs.

Consider, then, the situation when a CALL is the last line of a CASE-OF expression group. As the program is written, the GOSUB is never executed because it becomes preceded by the GOTO. There is another related problem that arises from the appending of a GOTO on the last line of a CASE expression group. If the last line of this group is an IF statement, there must be an ELSE clause included *if* the CASE construction includes an !ELSE DO statement group. Otherwise, when the IF statement is false, the GOTO will not be executed and the !ELSE DO statement group *will* be executed. With these two modifications made, and the last quirk kept in mind, NBASIC can quickly become an indispensable part of programming in this most widespread of languages.

Both N. C. Shammass in particular and *Dr. Dobb's* in general deserve great praise for the quality and usefulness of their articles.

Sincerely,
Dreas Nielsen
234 NW 30th St.
Corvallis, OR 97330

Remarks on RSA

Dear Sirs:

Thank you for a most interesting article on the Rivest-Shamir-Adleman (RSA) Public Key Systems by C. E. Burton in the March 1984 issue. This discourse is well written and certainly very needed. I would, however, like to caution the readers against too heavy a reliance on the security aspects of RSA.

Earlier this year Gustavus Simmons, James Davis, and Diane Holdridge of Sandia National Laboratories were able to factor the last of the Mersenne primes ($2^{2251}-1$). By using parallel processing of number clusters it is simple to extrapolate that RSA will no longer be a secure system.

Undoubtedly for general use RSA will continue to be valid. However, with some

of these newly developed techniques the only truly secure system must be the old, one-time pad system, in which the volume of ciphertext is insufficient to analyze statistically, and the key changes with a frequency to prevent valid analysis.

A good basic text for your readers so interested is *Cryptography, A Primer* by Alan G. Konheim (John Wiley & Sons, 1981).

Please keep up the good work. I certainly look forward to your publication each month.

Cordially,
James R. Criscione Jr., M.D.
President
Med-Data, 246 Grand Avenue
Kirkwood, Missouri 63122

Dear Dr. Dobb:

It was good to hear about an old friend, RATFOR, in Mr. Burton's article on the PKS in the March '84 issue of *Dr. Dobb's*. I have run several tens of thousands of lines of code through the RATFOR preprocessor and was very grateful for its services in an environment where Fortran was the only compiler available. But I am somewhat ambivalent about promoting its usage when there are viable alternatives.

My negative feelings toward RATFOR are summarized by the following factors:

- (1) relatively few people use RATFOR (or have even heard about it) and it is difficult to find a community of users for sharing experiences or software,
- (2) installation of RATFOR can be difficult and occasionally short circuited by versions of Fortran with non-standard limitations,
- (3) the added time for preprocessing on a small micro can be excessive,
- (4) temptations to hack RATFOR into "new and improved" versions can destroy code transportability, and
- (5) we are still using Fortran with all its fundamental limitations.

Fortran has far outlived its useful purpose (if it ever had one) but it is, admittedly, one of the most commonly available compiler languages on minis and midis and maxis. I heartily recommend RATFOR as a salve to soften the agony of having to deal with this unwieldy Tyrannosaurus. Mssrs. Kernighan and Plouger managed to make far better use of their time developing RATFOR than the committee that came up with Fortran '77.

An initial perusal of the article also revealed a typo in the multiplication routine descriptive text: the line "M5" i index should read "i=i-1" not "i=i-i". I also would suggest that Mr. Burton can save some computer time by removing the "mod" and division operations from the multiple-precision add and subtract functions. By using the facts that the sum is always going to be less than twice the radix and the absolute value of the difference is always less than the radix, the C code in Figure (at right) shows "division/mod-less" evaluations.

If we declare:

```
long carry, acc;
unsigned short *u, *v, *w;
```

then we can define RADIX to be "power (2, n)" (2^{*n} for Fortran folks) where n is the number of bits in a type "short" word. This will allow us to compute the equivalent of about 4.5 decimal digits per loop iteration on a machine with 16-bit type "short." Of course, when debugging the system we can define RADIX as 10 to facilitate formatting. I would also tend to make RADIX a compile-time definition rather than a runtime argument for the PKS software.

The last comment relates to Mr. Burton's statement at the end of the addition algorithm text that the Fortran intrinsic "INT(x)" is equivalent to "floor (x)." This is only true for positive values of x. "floor" (related to ALGOL's "entier") is correctly stated as the greatest integer less than or equal to x. Consequently:

```
floor(-3.45) -> -4
```

But the Fortran intrinsic yields:

```
INT(-3.45) -> -3!
```

I didn't see that Mr. Burton ever used it, but the statement was rather careless and should have been caught in technical review.

Obviously I've found Mr. Burton's article interesting and intend to follow along the steps to producing a public key encryption system as a diversion from some of my more mundane programming activities. It takes me back to the "secret" messages of Capt. Midnight, et al., and the kids' radio shows of the '40s. The trouble is, our decoding rings have gotten a little more expensive. Maybe Dr. Dobb can have "secret" messages about next month's articles.

Sincerely,
Gerald I. Evenden
Box 1027
North Falmouth, MA 02556

■ ■ ■

```
carry = 0;
while (w >= ws) { /* basic addition loop */
    acc = *u-- + (*v-- + carry);
    *w-- = (carry = acc >= RADIX) ? acc - RADIX : acc;
}

carry = 0;
while (w >= ws) { /* basic subtraction loop */
    acc = *u-- - (*v-- - carry);
    *w-- = (carry = acc < 0) ? acc + RADIX : acc;
}
```

Figure

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“As a dBASE II beta test site the past two years, we were reluctant to even try Q-PRO 4. Now we write all our commercial applications in Q-PRO 4. We find it to be an order of magnitude more powerful than dBASE II.

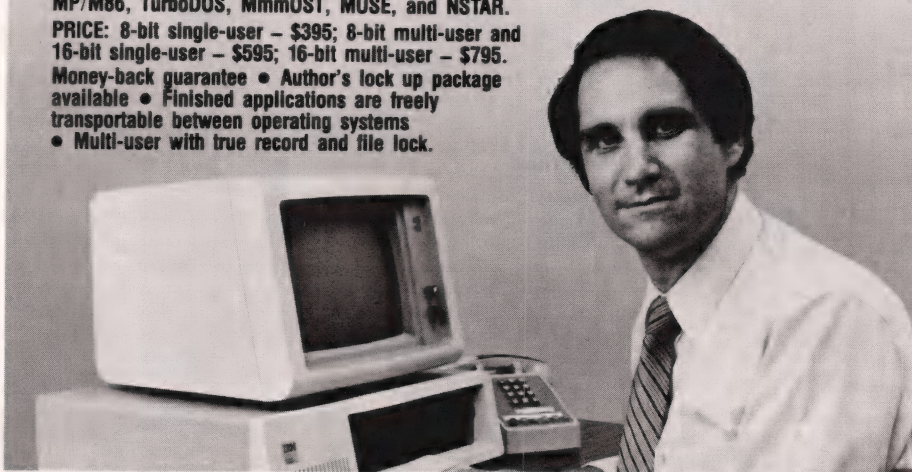
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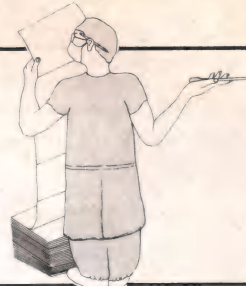
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by D.E. Cortesi, Resident Intern

MiniReview: Quasi-Disk

Late last year we decided to reward our S-100 system for three years of faithful work by giving it some new hardware. One thing it had been pining for was an electronic drive. It would be nice to say that we did a careful engineering analysis of the products on the market, but in fact — tell the truth and shame the devil — we merely checked the prices of all the RAM-drive boards we could find in the ads in one month's worth of computer magazines.

The cheapest one was the Quasi-Disk, from Electra-Logics, Inc. (39 Durward Place, Waterloo, Ontario, Canada N2L 4E5; (519) 884-8200). Its retail price of \$799 for 512K was, in December 1983, half that of its nearest competitor. Never ones to let engineering details blind us to the bottom line, we ordered one, plus a battery backup unit at \$159.

The order was held up because of a parts shortage, but Electra-Logics was decent enough to hold our check, only cashing it after it shipped the board early in February. The board arrived in mid-February, and the battery backup unit trailed in in early March.

Once it had arrived, the Quasi-Disk gave a good account of itself. Following the manual, we cut one trace (pin 53), which appears as ground in the IEEE standard but as a disable signal in our system. That done, we slotted the board into the system and fired it up, and the system worked normally. The package included a good diagnostic program that ran correctly under CP/M Plus; it reported that the board was working.

The Quasi-Disk package contains a lot of software (including a self-installing disk driver and a print spooler), but all of it is designed to work with CP/M 2.2. We couldn't test it because we are on CP/M Plus exclusively. It took us several hours to ferret out the details of how to read and write the board as a pseudo-disk and to create a new module for the CP/M Plus BIOS. Installing the code wasn't hard, however, since the CP/M Plus BIOS is modular. All the Quasi-Disk code went into a separate assembly; the names of its public entry points went into the drive table; the BIOS was relinked and a new system generated; and we were up.

We made the board appear to the rest of the system as a disk of 64 tracks, each holding eight 1K physical sectors. The distributed software treats the "disk" as one having 128-byte sectors, but we wanted to reduce the traffic between the BDOS

and the BIOS. Whereas the distributed code uses a 1-byte checksum for each "sector," we reserved 2K of the board to hold true 16-bit CRC codes. No CRC errors have been trapped in six weeks of operation.

The Quasi-Disk is much faster than a mechanical drive, but access to it isn't instantaneous. Data transfer takes just as long as it does to a real disk, but there are no seek or rotational delays. We have a disgustingly disk-bound Sort program. When it sorts a 60K file on disk, it takes 15 minutes 25 seconds. When its work files are on the Quasi-Disk, it runs in 9 minutes 25 seconds, 61% of the mechanical time. The extra six minutes of the disk sort are entirely devoted to head motion and rotational delays — a sobering thought.

Speed is not the Quasi-Disk's only benefit. It turned out to be very nice just to have a third drive. Under CP/M Plus, the PROFILE.SUB that runs automatically at boot time can load that drive with the 100K of standard utilities, then set the drive-search path so that the system searches for commands first on drive M, then on drive A. That lets us omit the standard commands from other disks but still allows us to access them, quickly and silently, at any time.

The battery backup unit comprises a transformer that plugs into the wall and a black box, the size of a carton of cigarettes, that is stuffed full of sealed gel cells. A ribbon cable from the black box snakes into the computer, where it plugs into the Quasi-Disk. When system power is off, the transformer keeps the board alive. If the electric service fails, the gel cells can take over for a couple of hours. A longer outage drains the batteries, losing data.

In our judgment, the Electra-Logics Quasi-Disk is a sound, well-made piece of hardware at a very good price. Its documentation is complete, although not well organized. Its supporting software is entirely oriented to CP/M 2.2, so the CP/M Plus user has to be able to roll his own. That's a pity, because it's the flexibility of CP/M Plus that makes the Quasi-Disk a really convenient extension of the system.

Fooling RMAC

Relocating assemblers such as Digital Research's RMAC make a distinction between relocatable values and nonrelocatable ones. The difference is hard to grasp at first, and if you fail to grasp it,

you may be sorely puzzled by the assembler's actions. Even when you do grasp it, the assembler's rules on what you can and can't do with a relocatable value can cramp your style.

A label is a relocatable value. Define a label:

```
Here: mvi a,1
```

Now the value of the symbol "Here" has been set as a 16-bit number, the contents of the assembler's location counter at that point. The number is a relocatable value, however. The value of "Here" is only the relative offset of "Here" within its particular segment. "Here" won't be at that location when the program runs; its actual storage address will be offset by some amount that can't be known at this time.

Define two labels in the same segment:

```
Here: mvi a,1
```

```
There: ora b
```

Both are relocatable. The assembler will permit you to subtract them,

```
dw There-Here
```

because the difference between them is a constant — it will be the same no matter where the linker puts the program. That is true only when the labels are defined in the same segment, of course. The relative origins of the code and data segments can't be known at assembly time, so the difference between a code label and data label can't be known.

The assembler also can allow you to add or subtract a constant from a relocatable value, so:

```
dw There-16
```

```
dw Here+5
```

It can permit that because a linker that supports the standard REL-file format must permit adding a constant to a relocatable value. The algebraic addition will be performed at link time; the assembler only needs to record a reference to the (future) location of the label and to record the constant.

No other manipulations are permitted on relocatable values. The value of, say, Here AND 0FFh can't be known at assembly time. Nor can the sum of two relocatable values be known. You can usually get around these things, if only by coding instructions that will carry out the evaluation when the program is executed.

What can't be gotten around is the need to evaluate macro operands that are relocatable values. In particular, RMAC doesn't allow any relocatable value to be

evaluated in an IF statement.

This caused us a problem. We were making a set of macros in which we wanted either to save and load a register or leave it alone before doing something. In other words, we wanted to code something along these lines:

```
if ... some test of an operand ..
    push d
    lxi d,operand
endif
```

One way to do this is to allow an omitted operand to mean one thing and a stated operand the other:

```
if not nul operand
    push d
    lxi d,operand
endif
```

But omitting operands is tricky and makes the code hard to read. It would be a lot nicer, and a lot harder to err, if the user had to write some special keyword — say, “noload” — to specify that the register is already loaded.

Now, the DRI assemblers provide no method by which you can test the literal, superficial encoding of a macro operand. There is no way to code the test, “If the user wrote exactly ‘noload’ then....” Some assemblers for the 8086 do allow that, using the angle brackets as meta-quotes. But in MAC and RMAC, if you code

```
if operand ne noload
```

the assembler will compare the assigned values of “operand” and “noload,” *not* the character strings that name them.

Very well, we thought, we will define our keywords in equate statements, giving them highly unlikely values, e.g.,

```
noload equ 0abcdh
```

Now we can write

```
if operand ne noload
```

and the assembler will compare the value substituted for “operand” to the value equated to “noload,” and we will have our test.

Nope. The value assigned to “noload” is nonrelocatable. If the value substituted for “operand” is relocatable, the IF statement will produce an error message, because we are trying to mix relocatable and nonrelocatable values in one expression.

Oh dear, are we stumped? Not for long. A careful reading of the rules for the substitution of macro operands into macro parameter names reveals an out.

If a macro operand is coded with a leading percent sign, the assembler will evaluate it and substitute not the value with its attached attribute of relocatability, but a simple string of decimal digits. That leads us to the following relocation-stripping macro:

```
unrel macro operand
```

```
@unrel set operand
endm
```

It does nothing but store the value it was given in a global name. The trick is in how it is used. Within our main macro, where we want to compare for the value of keyword, we now write

```
unrel %operand
if @unrel ne noload
    push d
    lxi d,operand
endif
```

The percent sign strips the attributes from “operand.” Whatever happens to be substituted for it, be it a relocatable label or not, the value assigned to “@unrel” is a simple constant. That can be compared to the equated value of “noload” without error. The full treatment ends up as:

```
some macro operand
if not nul operand
    unrel %operand
    if @unrel ne noload
        push d
        lxi d,operand
    endif
else
    +++ operand required as
    address or 'noload'
    exitm
endif
... etc, etc,
if @unrel ne noload
    pop d
endif
endm
```

The user is forced to code some operand. If the operand is omitted, the invalid expression “+++” forces the assembler to display the message line. In that line, the keyword is quoted. If it weren’t, the assembler would substitute for it, producing the error message “operand required as address or 43981,” 43981 being the value 0abcdh equated to “noload.”

DIR Not-Quite-So-Full

CP/M Plus has an extensive DIR command, one that can produce a wide variety of displays. It is very useful, but it is also a trifle verbose. When you ask for a full display, you get:

- a blank line
- a line, “Scanning Directory”
- another blank line
- a line, “Sorting Directory”
- another blank line
- column headings
- another blank line
- a line of dashes
- another blank line

Then, finally, you see the display of files, sizes, timestamps, etc. These extra lines are unnecessary. Often they push off the screen previous commands that one would like to refer back to.

We worked out how to stifle some of these lines. If you (the six of you that have CP/M Plus) would like to stifle them as well, you can do it this way. Load up DIR.COM under SID, using this sequence:

```
rename dir.old=dir.com
sid dir.old
```

Check these five hex addresses for the given instructions:

```
2091 CALL 30E2
24F7 CALL 30E2
2DF0 CALL 272C
2DF6 CALL 272C
2E2D CALL 272C
```

If your DIR.COM is the same as ours, that’s what you’ll find. The first two calls produce the “Scanning” and “Sorting” messages and the blank lines that follow them, while the others produce blank lines around the heading.

Replace each CALL with three NOP instructions, then write a new DIR file, using

```
-wdir.com
```

Test the command. It should produce a more compact display.

Without Fear or Good Taste

Dear Reader, the ol’ mailbox is running dry. What has your system done to surprise you lately? What has your operating system done to disgust you, and how did you get even with it? Know any good puzzles? Gotta have input, gotta get some of the cobwebs off the chairs in the waiting room at the old Clinic.

Hey, I know, let’s have a contest! (Picture Mickey Rooney: “Hey, gang, I know — we’ll put on a *show*!”) Sure. Let’s hold the first (and last) annual ZOSO sound-alike contest. Surely you remember ZOSO, the vile-tempered person who used to hold forth with outrageous, near-libelous, dead-accurate opinions on the old CPMUG disks?

If you can’t think of anything else to write about (puzzles, system discoveries, perils and pitfalls), then send us your best imitation of ZOSO: a page of scornful, acerbic, sneering commentary on some aspect of the personal-computer scene. We’ll print the best ones that our lawyer will approve. You’ll feel *much* better afterward.

■■■

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CP/M on the Commodore 64

Including Two BIOS Modifications

After the recent outcry about the correct spelling of the word kernel, we thought it interesting that the documentation for the Commodore 64 spelled the word kernal. Because this article refers to the Commodore "kernal" specifically, we have decided to use Commodore's spelling in this instance. — Ed.

The Commodore 64 has the potential to become one of the least expensive "real" computer systems available. Although most people know that the C-64 has a poor version of BASIC and that the OS doesn't really qualify as an operating system, not as many people know that they don't have to be a captive of Commodore's firmware.

The C-64 contains 64K of real RAM. Some of it is hidden under the ROM that holds the BASIC and the ROM that holds the OS kernal, but any program can switch out both of these ROMs to give access to the RAM underneath. Commodore is marketing a CP/M package for the C-64 that takes partial advantage of this hidden RAM by switching out the BASIC but leaving the OS I/O kernal switched in. Their implementation results in a computer that can run a 48K version of CP/M 2.2 (Although it is not the subject of this article, I'm convinced that a larger version of CP/M is possible with a rewrite of the BIOS.)

The CP/M package, which is similar in concept to the CP/M for the Apple, consists of a Z80 co-processor that plugs into the expansion port on the back of the keyboard and a CP/M system diskette. When the C-64 is running CP/M, the Z80 and the C-64's native processor (the 6510) take turns running out of the common memory. The 6510 becomes a slave processor; the Z80 turns it on whenever it requires I/O. Communication between the two processors is through data and commands left in memory. As with all other CP/Ms, only the BIOS is customized for the Commodore; the BDOS is not aware of the existence of the 6510.

by Walt Piotrowski

Walt Piotrowski, R. D. 1 Box 582, Afton, NY 13730.

The CP/M system is started with the C-64 running in its native mode. After plugging the CP/M cartridge into the back of the C-64, the user loads a CP/M boot program, called CPM, from the system diskette just as if it were a BASIC program. This boot program, called BOOT65 in the Commodore CP/M manual, loads in two other routines. The first is the 6510 portion of the BIOS (BIOS65), and the second is a Z80 boot routine (BOOT80). Once both routines are in place, BOOT65 switches on the Z80, and from this point on the Z80 is in charge. The Z80 boot routine loads in the Z80 portion of the BIOS (BIOS80) and the rest of CP/M.

The interface between the two parts of the BIOS is very nicely designed and very clean. Ten memory locations serve as a communication region, and a 256-byte buffer holds a full C-64 disk sector. When the Z80 part of the BIOS needs some physical I/O, it puts the required command information in the communication area (locations \$900-\$90A in the 6510 address space), switches itself off, and turns the 6510 on. The 6510 picks up the command, does what is required, then switches back to the Z80. The hardware is arranged so that both computers resume execution at the instruction following the instruction that performed the switch (plus one byte).

Because both processors required access to a set of low-numbered memory addresses to function reasonably, the address spaces in the two machines are offset from each other. The 6510 keeps its low memory data in the location adjacent to the "real" zero memory location. As shown in Figure 1 (page 15), the zero memory location for the Z80 is actually at location \$1000 in this 6510 address space. Because of the offset of \$1000, the communication area at \$900 in the 6510 address space is at location \$F900 in the Z80 space (see Figure 2, page 15). In other words, \$1000 is added to every Z80 address; hence, a Z80 access to \$F900 yields \$0900, and a Z80 access to \$0000 reaches \$1000.

Adding a Second Drive

I get the impression that Commodore rushed to market with CP/M. The software and the documentation both have some shortcomings. The biggest problem is that the BIOS can communicate with only one disk unit. It can talk to both drives in a Commodore 4040 unit or to

the single drive in a 1541, but it cannot communicate with two or more 1541 drives. If you have a 1541, you can still use an A and a B "drive" in CP/M, but each time you switch between A and B, you have to swap diskettes in and out of a single 1541. The software in the BIOS always tells you when the swap is required. I have two 1541s, however, and I quickly became annoyed with diskette swapping in one of them while the other sat unused. What I did about it follows.

The manual supplied by Commodore contains complete listings of all of the Z80 code for CP/M, but it does not contain listings for any of the 6510 code. The Z80 listings are well commented and easy to read. Because of this and because of the cleanliness of the interface between the two parts of the BIOS, I was able to follow the 6510 code with the use of a disassembler.

The changes that I made to allow CP/M to use two 1541 drives are relatively simple. They are so simple that I am surprised that Commodore did not include this capability in the original package. These modifications are shown in Listing One (page 18). The first four sections of this listing are patches that replace some of the original BIOS65 code. The last sections are small additional routines that are called by the patches; they fit in a section of memory reserved for the BIOS but actually unused.

The first patch routes the processing of all BIOS65 commands from the Z80 through the new routine called TESTIT. This routine checks to see if the command is a disk operation. If it is, the routine compares the drive number in the command with the drive number that was accessed on the last disk command. If they are the same, control returns to BIOS65. If they are different, the routine just closes the disk channels then returns control to BIOS65. BIOS65 discovers that the channels are closed when it attempts to communicate with the disk and tries to reopen them. The last two patches route the open requests through the new routines called OPEN15 and OPEN2, which open the channels to the correct disk. The changes make minimal impact on the original program. All of the disk errors that are detected and reported back to CP/M still function as they did originally.

A bigger part of the problem was coming up with a way to make the changes permanently on a CP/M diskette.

Since my 6510 assembler and loader do not run under CP/M, I chose to make all of the changes on the 6510 in its native mode. This required writing a utility program to read the 6510 code from the diskette and to replace it, once it had been modified, back in the same sectors. This utility turned out to be longer than the changes themselves, although it was easier to write because I didn't have to explore someone else's machine language code first.

The utility (CPM65UT) is provided in Listing Two (page 19). The utility does not have the capability to make changes; it simply reads the 6510 code from the disk or replaces it. Therefore the utility must be used in conjunction with a loader or a machine language monitor. The 6510 code is read into memory by calling the utility at its read entry point (\$C000). It reads BOOT65 and BIOS65 into the locations where they normally reside (see Figures 1 and 2). The loader or monitor is then used to make the modifications. After the changes have been made, the utility is called at its write entry point (\$C003), and it writes the modified code back onto the disk. Its use with the loader in the Commodore Assembler Development System is discussed at the end of this article.

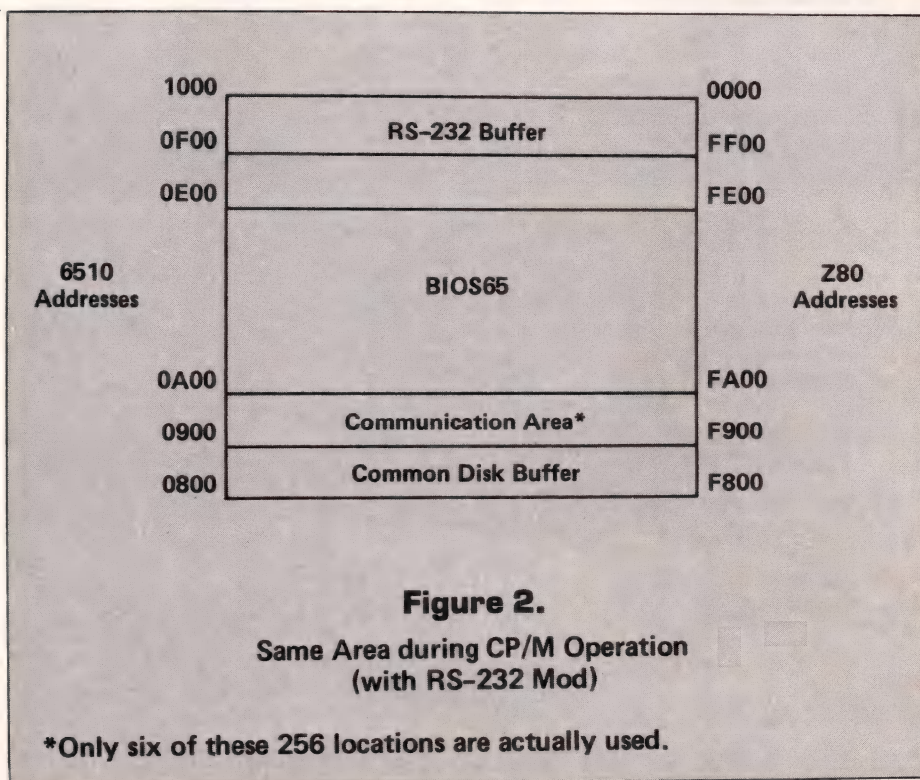
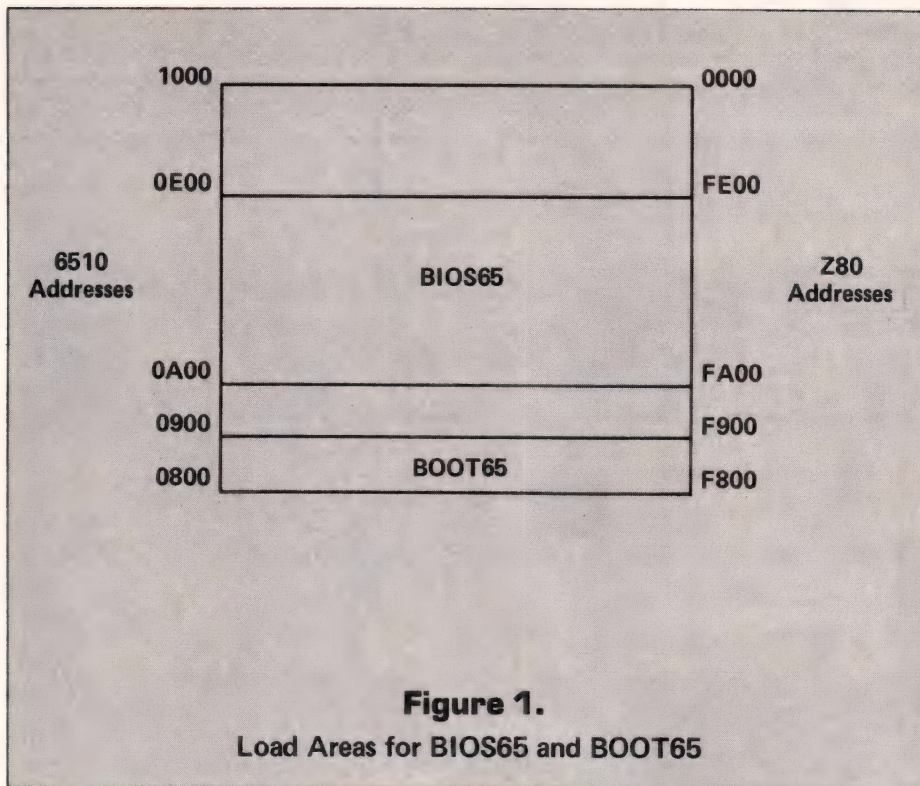
Adding a Serial Printer

My printer is not a Commodore printer. It's a DECwriter that I've had for several years; I modified it for RS-232 operation when I bought the C-64. While I was modifying the BIOS for two-disk operation, I also made a change to incorporate the DECwriter as the system printer. Listing Three (page 26) shows the changes to BIOS65 that make this substitution. The two changes, the one for the disks and the one for the RS-232 printer, are completely independent; you can incorporate either of them separately or use both together.

If you examine the Commodore CP/M manual, you will find that Commodore provides two user-definable functions in the interface between the Z80 and the 6510 parts of the BIOS. They also leave two 256-byte areas in the space reserved for BIOS65 to allow room for the 6510 code that you will write for these functions. Because I wanted to use all of the 48K bytes of memory that are available for CP/M programs and because I had no plans to implement any user functions, I moved the Commodore kernal's RS-232 buffers into one of these areas. Their normal location would have decreased the space available to CP/M by 4K bytes. If you choose to make the changes the same way I have, you will not be able to use the second user function in any program that also uses the printer.

Although it is unlikely, the possibility exists that more than one version of Commodore's CP/M is in circulation. Therefore, I've included comments in the two-disk modification to show the original memory contents for each of the four small patches. If you decide to make the changes, be sure to compare what is in your memory with what the listing

says should be there. If you find a difference and need some help, please let me know and I'll do all I can to assist you. If you decide to make the RS-232 modification, you should note that it is a large patch that completely overlays the printer code in the BIOS. If you find that the disk patch locations match up, you should be able to make the RS-232



change easily. If you have a problem, again I will be happy to help out.

After you have made the changes to the BIOS, you must run the CONFIG program that is located on the CP/M diskette. If you have made the disk drive changes, you should change to a two-drive configuration. The modifications made to the BIOS will allow you to change back and forth at any time. If you have CP/M configured for two drives, the program will access drives 8 and 9; if you have CP/M configured for one drive, the program will use drive 8 in the diskette swapping mode. (It is also possible to use more than two 1541 drives by making a minor change in BIOS80.) If you have made the RS-232 change,

you should use CONFIG to change the CP/M configuration so that BIOS80 thinks that you have the Commodore 4022 printer. If you leave it configured for the 1525 printer, BIOS80 makes a conversion from the ASCII character set that is used by CP/M to the 1525's character set.

You should be cautious about two things if you decide to buy Commodore's CP/M. The first is memory size. If you look through the CP/M Software Finder, you will find many programs that will run in 48K, but many also will not. All of the ones that I am now interested in fit in 48K, but this may not be true for you. The second is disk format. Commodore's 1541 disk format is unique, and

the software supplier for the program that you are interested in may not have this format available yet. I believe that this is a temporary problem and that it will be solved as the suppliers begin to realize that there are a lot of C-64 owners in the world.

As a final note, there is also the possibility of downloading public domain software from a bulletin board or another CP/M system using the inexpensive modems available for the C-64. I'm not aware of any software currently available for Commodore's CP/M that will do that, but I would like to hear from you if you know of any. If not, it doesn't look as if it would be that tough a program to write, making use of the user functions that are provided in the interface between BIOS65 and BIOS80. Any volunteers?

Using CPM65UT with the Commodore Assembler Development System

The Commodore Assembler Development System is a software package that contains an editor, an assembler, a machine language monitor, and a loader, along with several other useful programs. The package contains two versions of the loader. The version called HILOAD-ER64 resides in memory at \$C800 (51200 decimal). If you have previously assembled the CP/M changes, you can load both the CPM65 utility and the loader into memory at the same time. You then execute the utility by typing SYS49152. The utility will read the 6510 code into memory. When this is complete, you execute the loader by typing SYS51200. The loader will ask the name of the object file that you want to load. When loading is complete, you write the modified code back onto disk by typing SYS49155.

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(Listings begin on page 18)

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CP/M on the Commodore 64 (Text begins on page 14)

Listing One

CPMDSK.TX.

LINE#	LOC	CODE	LINE
00001	0000		*****
00002	0000		;
00003	0000		;
00004	0000		MODIFICATIONS TO BIOS65 FOR
00005	0000		TWO 1541 DISKS (8 AND 9)
00006	0000		;
00007	0000		;
00008	0000		W.G. PIOTROWSKI
00009	0000		STATE UNIV OF NY
00010	0000		BINGHAMTON, NY 13901
00011	0000		*****
00012	0000		;
00012	0000		BIOS65 = \$0A0C ;BIOS RETURN LOC
00013	0000		COMAND = \$0900 ;COMMAND LOC
00014	0000		DISKNO = \$0904 ;DISK NUM LOC
00015	0000		CLOSE = \$FFC3 ;KERNAL CLOSE ROUTINE
00016	0000		;
00017	0000		;
00017	0000		*=\$0A06 ;CHECK FOR DISK OPS
00018	0A06	20 B0 0C	JSR TESTIT ;WAS JSR \$0A0C
00019	0A09		;
00020	0A09		;
00020	0A09		*=\$0AFB ;REMOVE DISK NUM STORE
00021	0AFB	EA	NOP ;WAS STA \$0B67
00022	0AFC	EA	NOP ;
00023	0AFD	EA	NOP ;
00024	0AFE		;
00025	0AFE		;
00025	0AFE		*=\$0B9C ;BIOS TRYING TO OPEN 15
00026	0B9C	20 90 0C	JSR OPEN15 ;WAS LDA #15
00027	0B9F	EA	NOP ;
00028	0BA0	EA	NOP ; LDX #8
00029	0BA1	EA	NOP ; LDY #15
00030	0BA2		;
00031	0BA2		;
00031	0BA2		*=\$0BB6 ;BIOS TRYING TO OPEN 2
00032	0BB6	20 A0 0C	JSR OPEN2 ;WAS LDA #2
00033	0BB9	EA	NOP ;
00034	0BBA	EA	NOP ; LDX #8
00035	0BBB	EA	NOP ; LDY #2
00036	0BBC		;
00037	0BBC		;
00037	0BBC		*=\$C90 ;FREE SPACE IN BIOS AREA
00038	0C90	A9 0F	OPEN15 LDA #15 ;COMMAND CHANNEL
00039	0C92	20 C3 FF	JSR CLOSE ;CLOSE-JUST IN CASE
00040	0C95	AD 04 09	LDA DISKNO ;GET DISK NUM
00041	0C98	18	CLC ;SET UP FOR ADD
00042	0C99	69 08	ADC #8 ;MAKE 8 OR 9
00043	0C9B	AA	TAX ;DEVICE # IN X
00044	0C9C	A9 0F	LDA #15 ;CHANNEL IN A
00045	0C9E	A8	TAY ;ALSO IN Y
00046	0C9F	60	RTS ;GO BACK-CALL SETLFS
00048	0CA0	A9 02	OPEN2 LDA #2 ;DATA CHANNEL
00049	0CA2	20 C3 FF	JSR CLOSE ;CLOSE-JUST IN CASE
00050	0CA5	AD 04 09	LDA DISKNO ;GET DISK NUM
00051	0CAB	18	CLC ;SET UP FOR ADD
00052	0CA9	69 08	ADC #8 ;MAKE 8 OR 9
00053	0CAB	AA	TAX ;DEVICE # IN X
00054	0CAC	A9 02	LDA #2 ;CHANNEL IN A
00055	0CAE	A8	TAY ;ALSO IN Y

```

00056  OCAF  60          RTS          ;GO BACK-CALL SETLFS
00057  OCB0          ;
00058  OCB0          ;
00059  OCB0  AD 00 09    TESTIT LDA COMAND      ;SEE IF DISK COMND
00060  OCB3  F0 08          BEQ CLOSIT        ;0 IS DISK CMD
00061  OCB5  C9 01          CMP #1
00062  OCB7  F0 04          BEQ CLOSIT        ;1 IS DISK CMD
00063  OCB9  C9 06          CMP #6
00064  OCB8  D0 15          BNE LEAVE         ;6 IS DISK CMD
00065  OCB0  AD 04 09    CLOSIT LDA DISKNO      ;NOT FOR DISK-EXIT
00066  OCC0  CD D5 0C          CMP LSTDSK      ;GET CMD DISK#
00067  OCC3  F0 0D          BEQ LEAVE         ;COMPARE WITH LAST USE
00068  OCC5  8D D5 0C          STA LSTDSK      ;SAME-LET GO
00069  OCC8  A9 0F          LDA #15          ;DIFF-SAVE FOR NEXT
00070  OCCA  20 C3 FF          JSR CLOSE       ;COMMAND CHANNEL
00071  OCCD  A9 02          LDA #2           ;CLOSE IT
00072  OCCF  20 C3 FF          JSR CLOSE       ;DATA CHANNEL
00073  OCD2  4C 0C 0A          LEAVE JMP BIOS65 ;CLOSE IT
00074  OCD5          ;                     ;BIOS WILL OPEN AGAIN
00075  OCD5  00          LSTDSK .BYTE 0
00076  OCD6          .END

```

ERRORS = 00000

SYMBOL TABLE

SYMBOL VALUE

BIOS65	0A0C	CLOSE	FFC3	CLOSIT	OCCD	COMAND	0900
DISKNO	0904	LEAVE	OCD2	LSTDSK	OCD5	OPEN15	OC90
OPEN2	OCA0	TESTIT	OCB0				

END OF ASSEMBLY

End Listing One

Listing Two

CPM65UT.TX.

LINE#	LOC	CODE	LINE
00001	0000		*****
00002	0000		;
00003	0000		;
00004	0000		UTILITY PROGRAM TO READ OR WRITE
00005	0000		THE 6510 PORTION OF THE CPM BIOS
00006	0000		AND THE 6510 CPM BOOT ROUTINE
00007	0000		;
00008	0000		W. PIOTROWSKI
00009	0000		;
00010	0000		TO READ - JSR \$C000 SYS(49152)
00011	0000		TO WRITE - JSR \$C003 SYS(49155)
00012	0000		DISK DRIVE # AT \$C006 (49158)
00013	0000		*****
00014	0000		;
00015	0000		EQUATES
00016	0000		;
00017	0000		CMDCHN =15 ;DISK COMMAND CHANNEL
00018	0000		DATCHN =2 ;DISK DATA CHANNEL

(Continued on next page)

Listing Two

```

00019 0000      ZERO    = $30          ;ASCII ZERO
00020 0000      ONE     = $31          ;ASCII ONE
00021 0000      TWO     = $32          ;ASCII TWO
00022 0000      CR      = $D           ;ASCII RETURN
00023 0000      ;
00024 0000      SETLFS  = $FFBA        ;KERNAL ROUTINES
00025 0000      SETNAM  = $FFBD        ;
00026 0000      OPEN   = $FFC0        ;
00027 0000      CLOSE  = $FFC3        ;
00028 0000      CHKIN  = $FFC6        ;
00029 0000      CHKOUT = $FFC9        ;
00030 0000      CLRCHN = $FFCC        ;
00031 0000      CHRIN  = $FFCF        ;
00032 0000      CHROUT = $FFD2        ;
00033 0000      ;
00034 0000      FREKZ1 = $FB           ;FREE SPACE PAGE ZERO
00035 0000      FREKZ2 = FREKZ1+2     ; 4 LOCS AVAIL
00036 0000      BOOT65 = $801         ;NORMAL BOOT65 START
00037 0000      BUF     = $900        ;INPUT BUFFER START
00038 0000      BTSTRT = $904         ;BOOT65 START IN BUF
00039 0000      BIOS65 = $A00        ;BIOS65 LOAD ADDRESS
00040 0000      BOOTLN  = BIOS65-BTSTRT ;LENGTH OF BOOT65
00041 0000      ;
00042 0000      ;      MACRO DEF
00043 0000      ;
00044 0000      .MAC XAD              ;XFER ADDRESS
00045 0000      LDX #<?1             ;LO ORDER ADDRESS
00046 0000      LDY #>?1             ;HI ORDER ADDRESS
00047 0000      STX ?2               ;SAVE LO
00048 0000      STY ?2+1             ;SAVE HI
00049 0000      .MND
00051 0000      *=$C000
00052 C000      ;
00053 C000      ;      ENTRY POINTS
00054 C000      ;
00055 C000 4C 07 C0      JMP READ      ;(49152)
00056 C003 4C 0F C0      JMP WRITE     ;(49155)
00057 C006 09           DISK    .BYTE 9 ;DISK DRIVE #
00058 C007      ;
00059 C007 A9 00      READ    LDA #0     ;READ - ZERO
00060 C009 8D 57 C1      STA INOUT      ;SET FLAG
00061 C00C 4C 14 C0      JMP START      ;GO TO MAIN PROG
00062 C00F A9 01      WRITE   LDA #1     ;WRITE - ONE
00063 C011 8D 57 C1      STA INOUT      ;SET FLAG
00064 C014      ;
00065 C014      ;      OPEN DISK CHANNELS
00066 C014      ;
00067 C014 78           START   SEI       ;SHUT OFF INTERRUPTS
00068 C015 A9 0F      LDA #CMDCHN      ;COMMAND CHANNEL
00069 C017 AE 06 C0      LDX DISK       ;DISK ADDRESS
00070 C01A A8           TAY
00071 C01B 20 BA FF      JSR SETLFS     ;KERNAL
00072 C01E A9 00      LDA #0           ;NO NAME
00073 C020 20 BD FF      JSR SETNAM     ;KERNAL
00074 C023 20 C0 FF      JSR OPEN      ;KERNAL
00075 C026      ;
00076 C026 A9 02      LDA #DATCHN      ;DATA CHANNEL

```

(Continued on page 22)

Z80 Software

SOFTWARE DESCRIPTIONS

TPM (TPM I) - \$80 A Z80 only operating system which is capable of running CP/M programs. Includes many features not found in CP/M such as independent disk directory partitioning for up to 255 user partitions, space, time and version commands, date and time, create FCB, chain program, direct disk I/O, abbreviated commands and more! Available for North Star (either single or double density), TRS-80 Model I (offset 4200H) or II, Versafloppy I, or Tarbell I.

TPM-II - \$125 An expanded version of TPM which is fully CP/M 2.2 compatible but still retains the extra features our customers have come to depend on. This version is super FAST. Extended density capability allows over 600K per side on an 8" disk. Available preconfigured for Versafloppy II (8" or 5"), Epson QX-10, Osborne II or TRS-80 Model II.

CONFIGURATOR I

This package provides all the necessary programs for customizing TPM for a floppy controller which we do not support. We suggest ordering this on single density (8SD).

Includes: TPM-II (\$125), Sample BIOS (BIOS) SOURCE (\$FREE), MACRO II (\$100), LINKER (\$80), DEBUG I (\$80), QED (\$150), ZEDIT (\$50), TOP I (\$80), BASIC I (\$50) and BASIC II (\$100)
\$815 Value

NOW \$250

CONFIGURATOR II

Includes: TPM-II (\$125), Sample BIOS (BIOS) SOURCE (\$FREE), MACRO II (\$100), MACRO III (\$150), LINKER (\$80), DEBUG I (\$80), DEBUG II (\$100), QSAL (\$200), QED (\$150), ZTEL (\$80), TOP II (\$100), BUSINESS BASIC (\$200) and MODEM SOURCE (\$40) and DISASSEMBLER (\$80)

\$1485 Value

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MODEL I PROGRAMMER

This package is only for the TRS-80 Model I. Note: These are the ONLY CDL programs available for the Model I. It includes: TPM I (\$80), BUSINESS BASIC (\$200), MACRO I (\$80), DEBUG I (\$80), ZDDT (\$40), ZTEL (\$80), TOP I (\$80) and MODEM (\$40)

\$680 Value

NOW \$175

MODEL II PROGRAMMER

This package is only for the TRS-80 Model II. It includes: TPM-II (\$125), BUSINESS BASIC (\$200), MACRO II (\$100), MACRO III (\$150), LINKER (\$80), DEBUG I (\$80), DEBUG II (\$100), QED (\$150), ZTEL (\$80), TOP II (\$100), ZDDT (\$40), ZAPPLE SOURCE (\$80), MODEM (\$40), MODEM SOURCE (\$40) and DISASSEMBLER (\$80)

\$1445 Value

NOW \$375

BASIC I - \$50, a 12K+ basic interpreter with 7 digit precision.

BASIC II - \$100, A 12 digit precision version of Basic I.

BUSINESS BASIC - \$200, A full disk extended basic with random or sequential disk file handling and 12 digit precision (even for TRIG functions). Also includes PRIVACY command to protect source code, fixed and variable record lengths, simultaneous access to multiple disk files, global editing, and more!

ACCOUNTING PACKAGE - \$300, Written in Business Basic. Includes General Ledger, Accounts Receivable/Payable, and Payroll. Set up for Hazeltine 1500 terminal. Minor modifications needed for other terminals. Provided in unprotected source form.

MACRO I - \$80, A Z80/8080 assembler which uses CDL/TDL mnemonics. Handles MACROs and generates relocatable code. Includes 14 conditionals, 16 listing controls, 54 pseudo-ops, 11 arithmetic/logical ops, local and global symbols, linkable module generation, and more!

MACRO II - \$100, An improved version of Macro I with expanded linking capabilities and more listing options. Also internal code has been greatly improved for faster more reliable operation.

MACRO III - \$150, An enhanced version of Macro II. Internal buffers have been increased to achieve a significant improvement in speed of assembly. Additional features include line numbers, cross reference, compressed PRN files, form feeds, page parity, additional pseudo-ops, internal setting of time and date, and expanded assembly-time data entry.

DEVELOPER I

Includes: MACRO I (\$80), DEBUG I (\$80), ZEDIT (\$50), TOP I (\$80), BASIC I (\$50) and BASIC II (\$100)

\$440 Value

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DEVELOPER II

Includes: MACRO II (\$100), MACRO III (\$150), LINKER (\$80), DEBUG I (\$80), DEBUG II (\$100), BUSINESS BASIC (\$200), QED (\$150), TOP II (\$100), ZDDT (\$40), ZAPPLE SOURCE (\$80), MODEM SOURCE (\$40), ZTEL (\$80), and DISASSEMBLER (\$80).

\$1280 Value

NOW \$350

DEVELOPER III

Includes: QSAL (\$200), QED (\$150), BUSINESS BASIC (\$200), ZTEL (\$80) and TOP II (\$100)

\$730 Value

NOW \$300

COMBO

Includes: DEVELOPER II (\$1280), ACCOUNTING PACKAGE (\$300), QSAL (\$200) and 6502X (\$150)

\$1930 Value

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LINKER - \$80, A linking loader for handling the linkable modules created by the above assemblers.

DEBUG I - \$80, A tool for debugging Z80 or 8080 code. Disassembles to CDL/TDL mnemonics compatible with above assemblers. Traces code even through ROM. Commands include Calculate, Display, Examine, Fill, Goto, List, Mode, Open File, Put, Set Wait, Trace, and Search.

DEBUG II - \$100, A superset of Debug I. Adds Instruction Interpreter, Radix change, Set Trap/Conditional display, Trace options, and Zap FCB.

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QSAL - \$200, A SUPER FAST Z80 assembler. Up to 10 times faster than conventional assemblers. Directly generates code into memory in one pass but also to offset for execution in its own memory space. Pascal like structures: repeat...until, if...then...else, while do begin end, case...of. Multiple statements per line, special register handling expressions, long symbol names, auto and modular assembly, and more! This one uses ZILOG Mnemonics.

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DISK FORMATS

When ordering software specify which disk format you would like.

CODE	DESCRIPTION
8SD	8" IBM 3740 Single Density (128 bytes/26 sectors/77 tracks)
8DD	8" Double Density (256 bytes/26 sectors/77 tracks)
8XD	8" CDL Extended Density (1024 bytes/8 sector/77 tracks - 616K)

5SD	5.25" Single Density (TRS80 Model I, Versafloppy I, Tarbell I)
5EP	5.25" Epson Double Density
5PC	5.25" IBM PC Double Density
5XE	5.25" Xerox 820 Single Density
5OS	5.25" Osborne Single Density
5ZA	5.25" Z80 Apple (Softcard compatible)

TPM INFO

CODE	DESCRIPTION
TPM I:	
NSSD/H	North Star Single Density for Horizon I/O
NSSD/Z	North Star Single Density for Zapple I/O
NSSD/H	North Star Double Density for Horizon I/O
NSSD/Z	North Star Double Density for Zapple I/O
TRS80 I	TRS-80 Model I (4200H Offset)
TRS80 II	TRS-80 Model II
V18	Versafloppy I 8"
V15	Versafloppy I 5.25"
V18	Versafloppy II 8" (XD)
V15	Versafloppy II 5.25"
TRS80 II	TRS-80 Model II (XD)
TPM-II:	

Prices and Specifications subject to change without notice.

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ZTEL - \$80, An extensive text editing language and editor modelled after DEC's TECO.

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TOP I - \$80, A Text Output Processor for formatting manuals, documents, etc. Interprets commands which are entered into the text by an editor. Commands include justify, page number, heading, subheading, centering, and more.

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S-100 — **SMB II Bare Board \$50**, "System Monitor Board" for S-100 systems. 2 serial ports, 2 parallel ports, cassette interface, 4K memory (ROM, 2708 EPROM, 2114 RAM), and power on jump. When used with Zapple ROM below, it makes putting a S-100 system together a snap.

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CP/M on the Commodore 64

(Listing Continued, text begins on page 14)

Listing Two

```
00077 C028 AE 06 C0      LDX DISK          ;DISK ADDRESS
00078 C02B A8           TAY
00079 C02C 20 BA FF      JSR SETLFS        ;KERNAL
00080 C02F A9 01         LDA #1            ;ONE CHARACTER NAME
00081 C031 A2 56         LDX #<FILNAM      ;LO ADDRESS
00082 C033 A0 C1         LDY #>FILNAM      ;HI ADDRESS
00083 C035 20 BD FF      JSR SETNAM        ;KERNAL
00084 C038 20 C0 FF      JSR OPEN          ;KERNAL
00085 C03B               ;
00086 C03B               ;   SETUP FOR READ/WRITE LOOPS
00087 C03B               ;
00088 C03B A9 30         LDA #ZERO          ;FIRST SECTOR NUMBER
00089 C03D 8D 4A C1      STA USRMSG+9      ;RESET CMD MSG
00090 C040 A9 05         LDA #5            ;FIVE SECTORS
00091 C042 8D 54 C1      STA LOOPCTR       ; INITIALIZE LOOP CTR
00092 C045 AD 57 C1      LDA INOUT         ;IN OR OUT?
00093 C048 F0 06         BEQ RD            ;IN - GO TO READ
00094 C04A 20 B0 C0      JSR WRITIT        ;CALL WRITE SUBPROG
00095 C04D 4C 53 C0      JMP EXIT
00096 C050 20 5F C0      RD JSR READIT      ;CALL READ SUBPROG
00097 C053               ;
00098 C053               ;   WRAP UP AND RETURN
00099 C053               ;
00100 C053 A9 02      EXIT LDA #DATCHN      ;DATA CHANNEL
00101 C055 20 C3 FF      JSR CLOSE          ;KERNAL
00102 C058 A9 0F         LDA #CMDCHN       ;COMMAND CHANNEL
00103 C05A 20 C3 FF      JSR CLOSE          ;KERNAL
00104 C05D 58           CLI                ;INTS BACK ON
00105 C05E 60           RTS                ;MAIN PROG EXIT

00107 C05F               ;   *** READ FROM DISK ***
00108 C05F               ;
00109 C05F               ;
00110 C05F               ;   READ LOOP - READ 5 SECTORS
00111 C05F               ;
00112 C05F A9 31      READIT LDA #ONE        ;U1 IS AN INPUT CMD
00113 C061 8D 42 C1      STA USRMSG+1      ;PUT IN THE 1
00114 C064               ;
00115 C064               ;   XAD BUF,FREKZ1 ;BUF ADDR FOR INLP
00121 C06C      READ1  XAD BMSG,FREKZ2 ;DISK PTR RESET CMD
00127 C074 A9 08         LDA #BPM L       ;MSG LENGTH
00128 C076 20 01 C1      JSR CMDOUT        ;SEND IT
00129 C079               ;   XAD USRMSG,FREKZ2 ;DISK READ CMD
00135 C081 A9 0B         LDA #USRML       ;MSG LENGTH
00136 C083 20 01 C1      JSR CMDOUT        ;SEND IT
00137 C086               ;
00138 C086 20 1B C1      JSR INLP          ;BRING IN THE DATA
00139 C089               ;
00140 C089 EE 4A C1      INC USRMSG+9      ;POINT TO NEXT SECTOR
00141 C08C E6 FC         INC FREKZ1+1     ;POINT TO NEXT PAGE
00142 C08E CE 54 C1      DEC LOOPCTR       ;COUNT DOWN TO ZERO
00143 C091 D0 D9         BNE READ1         ;NOT DONE
00144 C093               ;
00145 C093               ;   MOVE "CPM" TO BASIC TEXT AREA
00146 C093               ;
00147 C093               ;   XAD BTSTRT,FREKZ1 ;SETUP TO MOVE BOOT65
00153 C09B               ;   XAD BOOT65,FREKZ2 ; TO NORMAL AREA
00159 C0A3 A0 00         LDY #0           ;INITIALIZE LOOPCTR
00160 C0A5 B1 FB      INMOV LDA (FREKZ1),Y ;GET BYTE
```

```

00161 COA7 91 FD          STA (FREKZ2),Y  ;MOVE TO WORK AREA
00162 COA9 C8            INY              ;LOOP CTR UP
00163 COAA 98            TYA              ;INTO A FOR COMPARE
00164 COAB C9 FC          CMP #BOOTLN    ;MOVED ALL?
00165 COAD D0 F6          BNE INMOV       ;NO-DO NEXT
00166 COAF 60            RTS              ;ALL DONE - LEAVE
00168 COB0                ;  *** WRITE TO DISK ***
00169 COB0                ;
00170 COB0                ;
00171 COB0                ;  LOOP TO MOVE "CPM" BACK TO BUF
00172 COB0                ;
00173 COB0                WRITIT XAD BOOT65,FREKZ1 ;SETUP TO MOVE BOOT
00179 COB8                XAD BTSTRT,FREKZ2 ; BACK TO BUFFER
00185 COC0 A0 00          LDY #0          ;INIT LOOP CTR
00186 COC2 B1 FB          OUTMOV LDA (FREKZ1),Y ;GET BYTE
00187 COC4 91 FD          STA (FREKZ2),Y  ;PUT IN OUTBUF
00188 COC6 C8            INY              ;LOOP CTR UP
00189 COC7 98            TYA              ;INTO A FOR COMPARE
00190 COC8 C9 FC          CMP #BOOTLN    ;ALL DONE?
00191 COCA D0 F6          BNE OUTMOV       ;NO-DO NEXT
00192 COCC                ;
00193 COCC                ;  WRITE LOOP - WRITE 5 SECTORS
00194 COCC                ;
00195 COCC A9 32          LDA #TWO        ;U2 IS AN OUTPUT CMD
00196 COCE 8D 42 C1       STA USRMSG+1    ;PUT IN THE 2
00197 COD1                ;
00198 COD1                XAD BUF,FREKZ1   ;BUF ADDR FOR OUTLP
00204 COD9                WRIT1 XAD BMSG,FREKZ2 ;DISK PTR RESET CMD
00210 COE1 A9 08          LDA #BPM L     ;MSG LENGTH
00211 COE3 20 01 C1       JSR CMDOUT      ;SEND IT
00212 COE6                ;
00213 COE6 20 2E C1       JSR OUTLP        ;OUTPUT THE DATA
00214 COE9                ;
00215 COE9                XAD USRMSG,FREKZ2 ;DISK WRITE CMD
00221 COF1 A9 0B          LDA #USRML     ;MSG LENGTH
00222 COF3 20 01 C1       JSR CMDOUT      ;SEND IT
00223 COF6                ;
00224 COF6 EE 4A C1       INC USRMSG+9    ;POINT TO NEXT SECTOR
00225 COF9 E6 FC          INC FREKZ1+1    ;POINT TO NEXT PAGE
00226 COFB CE 54 C1       DEC LOOPCT      ;COUNT DOWN
00227 COFE D0 D9          BNE WRIT1       ;NOT DONE YET
00228 C100 60            RTS              ;ALL DONE - LEAVE
00230 C101                ;
00231 C101                ;  SUBROUTINE TO OUTPUT CMD MSG
00232 C101                ;
00233 C101 8D 55 C1       CMDOUT STA MSGL    ;SAVE LENGTH
00234 C104 A2 0F          LDX #CMDCHN     ;COMMAND CHANNEL
00235 C106 20 C9 FF       JSR CHKOUT      ;OPEN FOR OUTPUT
00236 C109 A0 00          LDY #0          ;POINTER TO CHAR
00237 C10B AE 55 C1       LDX MSGL        ;NUM OF CHARS TO SEND
00238 C10E B1 FD          CMDLP LDA (FREKZ2),Y ;GET A CHARACTER
00239 C110 20 D2 FF       JSR CHROUT      ;SEND IT
00240 C113 C8            INY              ;NEXT CHAR
00241 C114 CA            DEX              ;LOOP CTR DOWN
00242 C115 D0 F7          BNE CMDLP       ;NOT DONE - NEXT
00243 C117 20 CC FF       JSR CLRCHN     ;KERNAL
00244 C11A 60            RTS
00245 C11B                ;
00246 C11B                ;  SUBROUTINE TO READ 256 BYTES
00247 C11B                ;
00248 C11B A2 02          INLP LDX #DATCHN ;DATA CHANNEL #
00249 C11D 20 C6 FF       JSR CHKIN       ;OPEN FOR INPUT
00250 C120 A0 00          LDY #0          ;BUFFER INDEX & LOOP CT
00251 C122 20 CF FF       INLP1 JSR CHRIN  ;GET A CHAR

```

(Continued on next page)

CP/M on the Commodore 64

(Listing Continued, text begins on page 14)

Listing Two

```

00252 C125 91 FB          STA (FREKZ1),Y  ;PUT IN BUFFER
00253 C127 C8            INY              ;NEXT SLOT
00254 C128 D0 F8          BNE INLP1       ;256 CHARS IN A SECTOR
00255 C12A 20 CC FF       JSR CLRCHN     ;KERNAL CLEAR CHANNEL
00256 C12D 60            RTS
00257 C12E                ;
00258 C12E                ; SUBROUTINE TO WRITE 256 BYTES
00259 C12E                ;
00260 C12E A2 02          OUTLP LDX #DATCHN  ;DATA CHANNEL #
00261 C130 20 C9 FF       JSR CHKOUT     ;OPEN FOR OUTPUT
00262 C133 A0 00          LDY #0         ;BUFFER INDEX & LOOP CT
00263 C135 B1 FB          OUTLP1 LDA (FREKZ1),Y ;GET A CHAR
00264 C137 20 D2 FF       JSR CHROUT     ;SEND IT
00265 C13A C8            INY              ;NEXT CHAR
00266 C13B D0 F8          BNE OUTLP1     ;256 CHARS IN A SECTOR
00267 C13D 20 CC FF       JSR CLRCHN     ;KERNAL CLEAR CHANNEL
00268 C140 60            RTS
00270 C141                ;
00271 C141                ; DATA
00272 C141                ;
00273 C141 55 31 3A       USRMSG .BYTE 'U1:'      ;U1:2 0 1 1
00274 C144 32            .BYTE ZERO+DATCHN
00275 C145 20 30          .BYTE ' 0 1 1'
00276 C14B 0D            .BYTE CR
00277 C14C              USRML  =*-USRMSG
00278 C14C 42 2D          BPMSG .BYTE 'B-P:'      ;B-P:2 0
00279 C150 32            .BYTE ZERO+DATCHN
00280 C151 20 30          .BYTE ' 0'
00281 C153 0D            .BYTE CR
00282 C154              BPML  =*-BPMSG
00283 C154 00            LOOPCT .BYTE 0
00284 C155 00            MSGL  .BYTE 0
00285 C156 23            FILNAM .BYTE '#'
00286 C157 00            INOUT  .BYTE 0          ;IN=0, OUT=1
00287 C158                ;
00288 C158                .END

```

ERRORS = 00000

SYMBOL TABLE

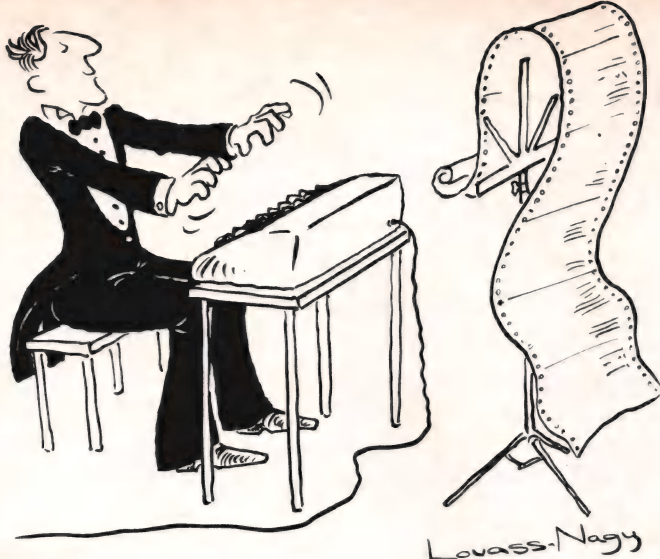
SYMBOL VALUE

BIOS65	0A00	BOOT65	0801	BOOTLN	00FC	BPML	000B
BPMSG	C14C	BTSTRT	0904	BUF	0900	CHKIN	FFC6
CHKOUT	FFC9	CHRIN	FFCF	CHROUT	FFD2	CLOSE	FFC3
CLRCHN	FFCC	CMDCHN	000F	CMDLP	C10E	CMDOUT	C101
CR	000D	DATCHN	0002	DISK	C006	EXIT	C053
FILNAM	C156	FREKZ1	00FB	FREKZ2	00FD	INLP	C11B
INLP1	C122	INMOV	C0A5	INOUT	C157	LOOPCT	C154
MSGL	C155	ONE	0031	OPEN	FFC0	OUTLP	C12E
OUTLP1	C135	OUTMOV	C0C2	RD	C050	READ	C007
READ1	C06C	READIT	C05F	SETLFS	FFBA	SETNAM	FFBD
START	C014	TWO	0032	USRML	000B	USRMSG	C141
WRIT1	C0D9	WRITE	C00F	WRITIT	C0B0	XAD	FFFF
ZERO	0030						

END OF ASSEMBLY

End Listing Two

(Listing Three begins on page 26)



Before Johann Sebastian Bach developed a new method of tuning, you had to change instruments practically every time you wanted to change keys. Very difficult.

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XASM05	6805		
XASM09	6809		
XASM18	1802		
XASM48	8048/8041		
XASM51	8051		
XASM65	6502		
XASM68	6800/01		
XASMZ8	Z8		
XASMF8	F8/3870		
XASM400	COP400		\$300.00 each
XASM75	NEC 7500	\$500.00	
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Listing Three

CPM232.TX.

LINE#	LOC	CODE	LINE
00001	0000		*****
00002	0000		;
00003	0000		MODIFICATIONS TO BIOS65
00004	0000		FOR AN RS-232 PRINTER
00005	0000		;
00006	0000		W.G. PIOTROWSKI
00007	0000		;
00008	0000		*****
00009	0000		;
00010	0000		EQUATES
00011	0000		;
00012	0000		FILE =128 ;FILE NUMBER
00013	0000		BUF232 =\$F00 ;NEW RS232 BUF LOC
00014	0000		CHAR =\$901 ;CHAR BEING PRINTED
00015	0000		;
00016	0000		SETLFS =\$FFBA ;KERNAL ROUTINES
00017	0000		SETNAM =\$FFBD ;
00018	0000		OPEN =\$FFC0 ;
00019	0000		CLOSE =\$FFC3 ;
00020	0000		CHKOUT =\$FFC9 ;
00021	0000		CLRCHN =\$FFCC ;
00022	0000		CHROUT =\$FFD2 ;
00023	0000		;
00024	0000		ENABL =\$2A1 ;RS232 STILL ACTIVE
00025	0000		ROBUF =\$F9 ;RS232 OUTBUF PTR
00026	0000		RIBUF =\$F7 ;RS232 INBUF PTR
00027	0000		;
00028	0000		*=\$A9F
00029	0A9F		;
00030	0A9F	AE E2 0A	LDX ENTFLG ;SEE IF FIRST ENTRY
00031	0AA2	D0 26	BNE OUTCHR ;ZERO - OPEN FILE
00032	0AA4		;
00033	0AA4		INITIAL ENTRY
00034	0AA4		OPEN FILE AND MOVE BUFFER
00035	0AA4		;
00036	0AA4	A2 01	OPENIT LDX #1 ;NOT ZERO MEANS ENTERED
00037	0AA6	8E E2 0A	STX ENTFLG ;PUT IN FLAG
00038	0AA9	A9 80	LDA #FILE ;FILE NUMBER
00039	0AAB	A2 02	LDX #2 ;RS-232 DEVICE
00040	0AAD	A0 FF	LDY #\$FF ;NO COMMAND
00041	0AAF	20 BA FF	JSR SETLFS ;CALL KERNAL
00042	0AB2	A9 02	LDA #2 ;TWO CHAR NAME
00043	0AB4	A2 E3	LDX #<SET232 ;LO ADDRESS
00044	0AB6	A0 0A	LDY #>SET232 ;HI ADDRESS
00045	0AB8	20 BD FF	JSR SETNAM ;KERNAL
00046	0ABB	20 C0 FF	JSR OPEN ;KERNAL
00047	0ABE	A2 00	LDX #<BUF232 ;BUFFER LO ADDR
00048	0AC0	A0 0F	LDY #>BUF232 ;BUFFER HI ADDR
00049	0AC2	86 F9	STX ROBUF ;KERNAL OUT BUF ADDR
00050	0AC4	84 FA	STY ROBUF+1 ;HI ORDER PART
00051	0AC6	86 F7	STX RIBUF ;MOVE INBUF TOO
00052	0AC8	84 F8	STY RIBUF+1 ; JUST IN CASE
00054	0ACA		;
00055	0ACA		CHARACTER OUTPUT

```

00056  OACA          ;
00057  OACA  A2 80    OUTCHR LDX #FILE          ;GET FILE NUM
00058  OACC  20 C9 FF          JSR CHKOUT        ;OPEN FOR OUTPUT
00059  OACF  B0 D3          BCS OPENIT          ;ERROR MEANS CLOSED
00060  OAD1  AD 01 09        LDA CHAR          ;GET CHARACTER AGAIN
00061  OAD4  20 D2 FF          JSR CHROUT        ;KERNAL
00062  OAD7  AD A1 02        WAIT LDA ENABL      ;GET STATUS
00063  OADA  29 01          AND #1             ;STILL RUNNING BIT
00064  OADC  D0 F9          BNE WAIT           ;HANG UNTIL DONE
00065  OADE  20 CC FF        JSR CLRCHN        ;CLEAR CHANNEL
00066  OAE1  60          RTS
00067  OAE2          ;
00068  OAE2  00          ENTFLG .BYTE 0         ;FIRST ENTRY FLAG
00069  OAE3  86          SET232 .BYTE $86,0     ;RS232 PARAMS
00069  OAE4  00
00070  OAE5          ;
00071  OAE5          .END

```

ERRORS = 00000

SYMBOL TABLE

SYMBOL VALUE

BUF232	0F00	CHAR	0901	CHKOUT	FFC9	CHROUT	FFD2
CLOSE	FFC3	CLRCHN	FFCC	ENABL	02A1	ENTFLG	OAE2
FILE	0080	OPEN	FFC0	OPENIT	0AA4	OUTCHR	OACA
RIBUF	00F7	ROBUF	00F9	SET232	OAE3	SETLFS	FFBA
SETNAM	FFBD	WAIT	OAD7				

END OF ASSEMBLY

End Listing Three



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dBASE II Programming Techniques

It seems that everyone nowadays is using a mailing list! Lawyers track clients, clubs chart members, and businesses of all types garner lists of names for mass mailings. I handle a small 1200-name mailing list for a missionary friend who sends field reports to his supporters every month.

Usually, a mailing list will eventually involve the Post Office, and if the list is long enough (200 pieces or more) bulk mailing can save money over regular first class mail. Ah, but there is a catch. The Postmaster expects you to pre-sort your mailing, count it, and have accurate zip

code information. Bulk mail is not generally forwarded when an incorrect zip code sends your letter to the wrong city even if the proper city and state are part of the address.

Exact zip code validation is impractical. However, there is a way to partially verify zip codes and validate the state. This technique should decrease errors and increase mass mailing efficiency and accuracy. This procedure could be written in high-level language, but for speed and compactness of code I chose to write it as a machine language subroutine.

ZIP-CHK.ASM assembles into a machine code subroutine that uses a table published by the Post Office to first verify that the two-character state abbreviation is correct then check that the zip code is within the range for that state as set by the table. The source listing is well commented and documented. It was written as a dBASE II subroutine but can easily

be adapted to any high-level language that can pass a string type memory variable to the called subroutine and modify that variable if required and pass it back to the calling program.

I got the idea for this program from Bertel Schmitt who wrote an earlier version as part of a file called DBASM.ASM, found on many RCP/M systems around the country. I modified and streamlined the routine, correcting a few errors in the original code. I added a symmetrical look-up table that increased accuracy and speeded the table search.

If you have a modem, you can find ZIP-CHK.ASM on several RCP/M systems, including the dBASE II system at (408) 378-8733. ■■■

by Gene Head

Gene Head, 2860 N.W. Skyline Dr.,
Corvallis, OR 97330.

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dBASE II Techniques Listing

```
*****
```

```
***** ZIP-CHK.ASM *****
```

```
*****
```

```
This machine-language subroutine is designed to be called by
a high-level language such as dBASE II or BASIC with a single
passed variable of exactly five characters like 'ST123', where
ST is the Post Office designated two letter abbreviation for
the state and 123 are the first three ZIP code digits of that state.
```

```
On return from this sub-routine, the passed variable is un-changed
if the ZIP code is valid for the state. If the two letter
abbreviation is invalid then the returned variable becomes
'ERR 1' or if the state is valid but the ZIP code is out of range
then the variable becomes 'ERR 2'.
```

```
The following command program could be used to verify a state
and ZIP code in a dBASE II data file:
```

```
*      ZIP-CHK.CMD
```

```
*
```

```
*      Note:   The following two lines of commands should be
*              a part of the main program initialization
```

```
*
```

```
*      LOAD ZIP-CHK
```

```
*      SET CALL TO 42096
```

```
*
```

```
*      STORE $(STATE,1,2)+$(ZIP,1,3) TO ZIP:CHK
```

```
*      CALL ZIP:CHK
```


dBASE II Techniques Listing (Listing Continued, text begins on page 28)

; Here when valid state was found so check if ZIP is within range

```
MATCH:  PUSH    H           ; Save pointer to TABLE ZIPS
        LHL    ZIPPNT      ; HL points to passed ZIP
        MOV    B,H         ; BC now points to passed ZIP
        MOV    C,L         ; ...and
        POP    H           ; .....HL points to TABLE ZIPS
```

; First check if passed ZIP is smaller than first TABLE ZIP

```
CALL    RANGE    ; Check first digit
JC      ERROR2   ; Carry set if too small
CALL    RANGE    ; Check second digit
JC      ERROR2   ; Carry set if too small
CALL    RANGE    ; Check last digit ONLY if. . .
JC      ERROR2   ; . . . first two were exact matches
```

```
DCX     B        ; Keep bumper is sync
MATCH1  DCX     B
DCX     B

PUSH    B        ; Swap compared elements
PUSH    H        ; so now we check for upper range
POP     B
POP     H
```

* UPPER LIMIT CHECK

```
CALL    RANGE    ; Check first digit
JC      ERROR2   ; Error out if too large
CALL    RANGE    ; Check second digit and error
JC      ERROR2   ; ...out if it is too large
RNZ     ; If zero then test is passed so return
        ; ...to calling program
CALL    RANGE    ; Check last digit ONLY if . . .
JC      ERROR2   ; . . .first two were exact matches

RET     ; RETURN to calling program all OK
```

* RANGE CHECKER

```
RANGE:  INX     B        ; Compare NEXT byte
        INX     H
        LDAX   B        ; Set CARRY if out of range
        CMP    M
        RET
```

; ERRORHANDLERS

```
ERROR1: LHL    ZIPPNT
        MVI    A,'1'
        JMP    ERROR
```

```
ERROR2: LHL    ZIPPNT
        MVI    A,'2'
```

* REPLACE VARIABLE WITH ERROR MESSAGE

```
ERROR:  LHL    ZIPPNT
        DCX    H
        MVI    M,'E'
```

```

INX      H
MVI      M,'R'      ;AND NOW ERR
INX      H
MVI      M,'R'
INX      H
MVI      M,' '
INX      H
MOV      M,A
RET                      ; Return to calling program
                      ; ...with passed variable set to ERROR

```

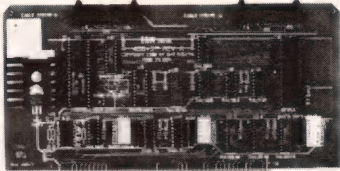
ZIPPNT: DS 2

; The following info is copied from the US Zipcode book.
; Small possessions and islands are not included but may be added.

TABLE:

DB	'AL350369'	DB	'NV890898'
DB	'AK995999'	DB	'NH030038'
DB	'AZ850865'	DB	'NJ070089'
DB	'AR716729'	DB	'NM870884'
DB	'CA900961'	DB	'NY100149'
DB	'CO800816'	DB	'NC270289'
DB	'CT060069'	DB	'ND580588'
DB	'DE197199'	DB	'OH430458'
DB	'DC200205'	DB	'OK730749'
DB	'FL320339'	DB	'OR970979'
DB	'GA300319'	DB	'PA150196'
DB	'HI967968'	DB	'RI028029'
DB	'ID932938'	DB	'SC290299'
DB	'IL600629'	DB	'SD570577'
DB	'IN460479'	DB	'TN370385'
DB	'IA500528'	DB	'TX750799'
DB	'KS660679'	DB	'UT840847'
DB	'KY400427'	DB	'VT050059'
DB	'LA700714'	DB	'VA220246'
DB	'ME039049'	DB	'WA980994'
DB	'MD206219'	DB	'WV247268'
DB	'MA010027'	DB	'WI530549'
DB	'MI480499'	DB	'WY820831'
DB	'MN550567'		
DB	'MS386397'	DB	ENDTAB
DB	'MO630658'		
DB	'MT590599'	END	
DB	'NE680693'		

End Listings



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If the computer had been invented in China, what problems would English-speaking people have to surmount in order to use it? To learn computers, a person who comes from an Oriental culture must overcome at least two major obstacles. The first is the natural language barrier and the second is the computer language barrier. Whenever I read an article on computers that is written in English, I first have to understand the English literal meaning, then the technical aspects of the article. Even though I have had many years of English education, I still have trouble now and then. This difficulty will diminish with time, but it will never disappear totally.

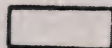
With this kind of painful experience in mind (would you guys give me a break and publish articles in plain and simple English?), I started a Chinese Forth computer project, which should be completed by the time this article is published. I primarily wanted to provide a computer system that is more easily accessible to my countrymen, the Chinese. After all, we make up more than a quarter of the world's population: over 1,000,000,000 people. Since the beauty of Forth has been established time and time again, it was, of course, my first choice without reservation. The whole project was written in Dai-E Systems' Forth Level II in both Chinese and English.

The significance of Chinese Forth (or any Chinese language computer system) is obvious. In Taiwan, as well as other Chinese communities, English is a mandatory second language in all schools. But no matter how well a Chinese person masters the English language, Chinese remains the first choice. Computer languages are only software tools invented to enable us to communicate with hardware. The closer this form of expression is to one's native language, the more comfortably the user can proceed, and with much better results.

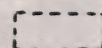
Many concepts expressed in Chinese have no English equivalent, and vice versa. This is one reason why translation is a difficult problem. Since the computer was

"My main objective is to provide the Chinese people with a simple but powerful computer language."

Dai-E Systems, Inc.									
HEX	B	9	A	B	C	D	E	F	
HEX	B 8765 B 4321	1000	1001	1010	1011	1100	1101	1110	1111
0	0000	128	144	SP 160	Ø 176	@ 192	イ 208	ゑ 224	ゑ 240
1	0001	129	145	! 161	1 177	ㄣ 193	尸 209	ㄣ 225	ㄣ 241
2	0010	130	146	" 162	2 178	ㄣ 194	日 210	ㄣ 226	ㄣ 242
3	0011	131	147	# 163	3 179	ㄣ 195	尸 211	ㄣ 227	ㄣ 243
4	0100	132	148	\$ 164	4 180	ㄣ 196	ㄣ 212	ㄣ 228	ㄣ 244
5	0101	133	149	% 165	5 181	ㄣ 197	ㄣ 213	ㄣ 229	ㄣ 245
6	0110	134	150	& 166	6 182	ㄣ 198	ㄣ 214	ㄣ 230	ㄣ 246
7	0111	135	151	' 167	7 183	ㄣ 199	ㄣ 215	ㄣ 231	ㄣ 247
8	1000	136	152	(168	8 184	ㄣ 200	ㄣ 216	ㄣ 232	ㄣ 248
9	1001	137	153) 169	9 185	ㄣ 201	ㄣ 217	ㄣ 233	ㄣ 249
A	1010	138	154	* 170	: 186	ㄣ 202	ㄣ 218	ㄣ 234	ㄣ 250
B	1011	139	155	+ 171	; 187	ㄣ 203	ㄣ 219	ㄣ 235	ㄣ 251
C	1100	140	156	, 172	< 188	ㄣ 204	ㄣ 220	ㄣ 236	ㄣ 252
D	1101	141	157	- 173	= 189	ㄣ 205	ㄣ 221	ㄣ 237	ㄣ 253
E	1110	142	158	. 174	> 190	ㄣ 206	ㄣ 222	ㄣ 238	ㄣ 254
F	1111	143	159	/ 175	? 191	ㄣ 207	ㄣ 223	ㄣ 239	ㄣ 255



Phonetic Characters



Tone Characters

Table I.

Chinese Phonetic Character Chart

by Timothy Huang

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29783 Town Center Loop West, P. O.
Box 790, Wilsonville, OR 97070.

born in the United States, most of the current Forth-related subjects are expressed in English: SPACE, SPACES, BLANK, BLANKS, etc. For the average American, these constructions are natural, but the Chinese do not express plurals in this manner; they have a different philosophy, a different way of thinking, and different forms of expression.

Forth is expressed nicely in English, so why not in the oldest language – Chinese? For the Chinese to realize real computer power (e.g., Forth power), it should be available in their own language.

My main objective is to provide the Chinese people with a simple but powerful computer language. I want to remove the English language barrier so that even Chinese children can use Forth. Furthermore, I would like to see the impact on Forth of exposure to the Chinese culture and language. I hope to see great and positive contributions and believe that only Forth can absorb this challenge.

Other less conceptual languages will have a difficult time, because the Chinese philosophy is very abstract.

Double (Multiple) Names

A Forth word with two different names can be made easily by:

```
: PUD DUP;
```

or

```
:FI [COMPILE] IF ; IMMEDIATE
```

but there are many deficiencies in this method. For example, the execution speed will be hampered because the new word(s) must execute at least one extra cycle of the inner interpreter.

In his article entitled "Turtle Talk," Glenn Tenney described a defining word, ALIAS, that stores the old word's cfa into the new word's pfa.¹ The new word (alias) is created as an immediate word: when alias is executed, the old word (parent) must be executed. This approach solved

some problems but also created its own. In our case, not all Chinese words are immediate.

Since the implementation of Dai-E Systems' Forth Level II (83 Standard) uses a separate header and body approach, we can achieve the double (multiple) name easily by simply creating a new header with a pointer pointing to the same body of the old word. The separated heads concept was first proposed and implemented by Klans Schleisiek.² I'm not arguing the respective merits of continuous or separated heads/bodies, but only pointing out how I did it. Using the separated heads scheme, the memory map of a word is shown in Figure 1 (below).

The pointer in the above structure is the key, since nothing forbids more than one head pointing to the same body. The only no-no is to have one head pointing to many bodies, which would result in a very interesting Forth system. Equipped with this understanding, we can make

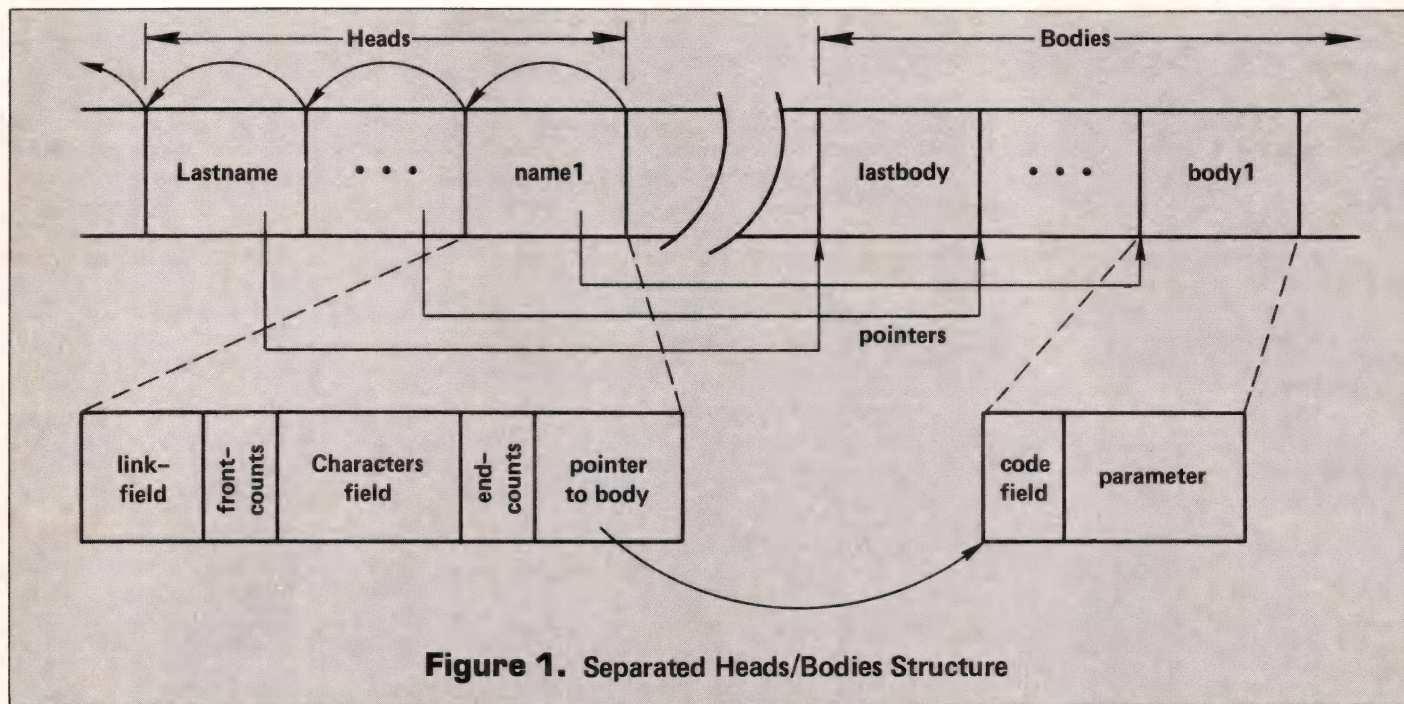


Figure 1. Separated Heads/Bodies Structure

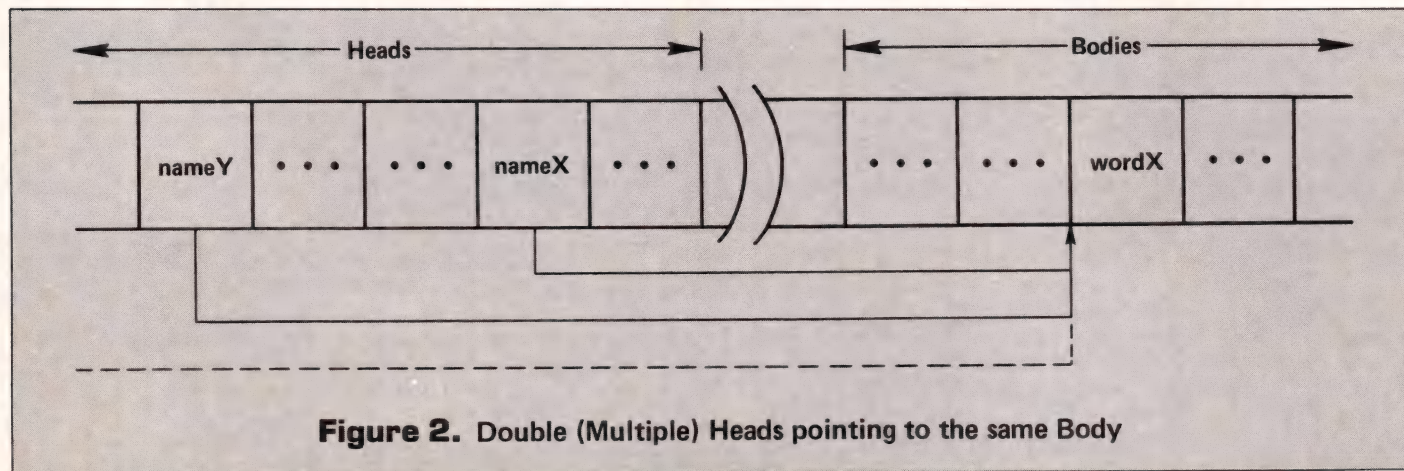


Figure 2. Double (Multiple) Heads pointing to the same Body

double (multiple) headers as shown in Figure 2 (page 33).

To accomplish this, we have to store the old pointer from the old word into the pointer location of the new name, as described in Figure 3 (below). The word C: should be used to generate new names. For example:

C: PUD DUP ;
C: FI IF ; IMMEDIATE

The new words (actually new names) could be either immediate or non-immediate words depending on whether we issue IMMEDIATE after the definition.

This simple approach not only eliminates one extra nesting level but also gives us the choice of indicating the immediate or non-immediate nature of a word. With this trick we can have one word behaving differently depending on which header we use; i.e., one name is immediate and the other is non-immediate.

Chinese Forth

Chinese characters are ideographic symbols. Each one is an individual entity, and there are more than 50,000 of them. Because it is impossible to make an ASCII table to include all of them, we took a simpler approach and used the phonetic characters rather than the actual ideograms. There are 37 phonetic symbols and five tone symbols, as shown in Table I

(page 32). With a proper combination of at least one, but no more than three, phonetic symbols and one tone symbol, all the ideographic characters can be expressed.

These phonetic characters can be placed into the higher portion of the ASCII table with the most significant bit on. This phonetic character set is called the "BER PER MER FER" (ㄅ ㄆ ㄇ ㄈ). This is the first thing learned when a person enters a formal education institution. The phonetic characters are learned first, then the pronunciation, then the ideographic characters. Eventually, phonetic characters (pronunciation) are no longer needed alongside each ideographic character.

As mentioned earlier, more than 50,000 ideographic characters exist now; however, there are only about 2,000 legal pronunciations (combinations of sounds and tones) for them. Thus, the homonym (different character with identical pronunciation) is a very annoying problem. Theoretically, each pronunciation can apply to about 25 different ideographic characters. However, the Chinese created a clever method for alleviating this confusion: they used multiple characters to form a phrase as often as possible rather than single characters. With phrases of at least two characters, the chance of a mix-up was greatly reduced. The telephone directory service of the Taiwan Telephone

and Telegraph Company is using this method in conjunction with their computer systems with great success.

For this reason, I decided to avoid single-character phonetic names for the Chinese Forth words. Each English Forth word was translated to a Chinese phrase of more than two characters. However, the math operators remained the same. Certain English characters used in the name fields were also preserved, such as ":", " ", "(", and so on.

Table II (page 36) lists all the required words in the 83 Standard. The first column is the original English, the second the equivalent Chinese ideographic characters, the third the phonetic names used in our system. Within the phonetic names, the first tone character, which is usually the blank character, was changed to a high raised "-" character to avoid the space character limitation of Forth names.

By using the phonetic characters, even though I cannot see the ideographic characters, I can pronounce the program and thus have no problem whatsoever in understanding what I have written. This computerized solution solves the 50,000-character ASCII table problem. Besides, this reflects the hope that Forth, a written language, might be a spoken language as well. Otherwise, why is there a pronunciation for words such as @ (fetch) or ! (store)? Chinese Forth not only can be written but also can be verbalized (spoken).

The other interesting thing regarding our Chinese Forth is, while decompiling the English-origin word, one may see half English and half Chinese, depending on how many English words were translated into their Chinese equivalents. This is because we utilized the double-header approach mentioned earlier.

References

1. Glenn S. Tenney. "Turtle Talk." *FORML*, 1981, pp. 521-542.
2. Klans Schleisiek. "Separated Heads." *FORTH DIMENSIONS*, Vol. II/5, p. 147.

The Dai-E Chinese Computer System includes a Victor 9000 microcomputer with 512K of RAM, Axiom IMP4 printer, and 5,000 of the most commonly used Chinese characters encoded to conform to the communication protocol selected by the U. S. Library of Congress, CCCII - Chinese Character Code for Information Interchange. In addition to their Forth system, they have a Chinese word processor. They should be able to use their system shortly on the British-made Apricot computer. They are also in the process of bringing the system up on other computers. - Ed. ■■■

(Table II begins on page 36)

Reader Ballot

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```

: C:  (S -----)  \ create double header
create                                \ make new name field
'                                       \ find the cfa of the old word
heads                               \ set dictionary pointer to header
here 2-                             \ into the new pointer address
!                                   \ store old cfa into new pointer address
bodies                             \ reset dictionary pointer to body portion
;

```

Figure 3.

Double (Multiple) Header Code

一九八三年電腦大展
達意資訊公司
正式展出
中文電腦系統
敬請多多指教

Figure 4.

Characters printed on Axiom IMP4

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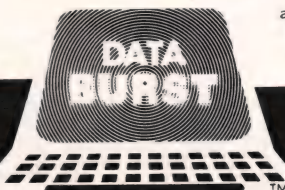
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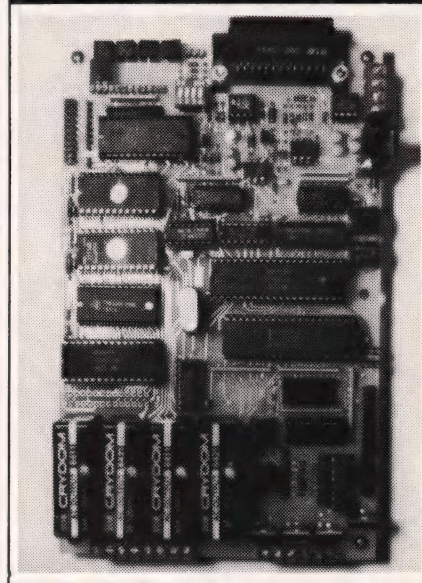


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(()) Indicates Chinese Pronunciation only

English Nucleus Layer	Chinese Character Name	Chinese Forth Phonetic Name
!	(儲存)	!
*	(相乘)	*
*/	(相除)	*/
+	(相加)	+
+!	(加存)	+!
-	(相減)	-
/	(相除)	/
/MOD	(餘除)	/MOD
0<	(小於零)	0<
0=	(等於零)	0=
1+	(壹加)	1+
1-	(壹減)	1-
2+	(貳加)	2+
2-	(貳減)	2-
2/	(貳除)	2/
<	(小於)	<
=	(等於)	=
>	(大於)	>
>R	(到回疊)	>R
?DUP	? 重覆	? ㄒㄨㄟ / ㄘㄨㄟ
@	(取得)	@
ABS	絕對值	ㄞㄨㄟ / ㄎㄨㄟ ㄘㄨㄟ
AND	聯與	ㄎㄨㄟ ㄘㄨㄟ
C!	(存位)	C!
C@	(取位)	C@
CMOVE	移位元	ㄟ / ㄘㄨㄟ ㄘㄨㄟ
CMOVE>	反移位	ㄘㄨㄟ ㄟ / ㄘㄨㄟ
COUNT	計算	ㄘㄨㄟ ㄟ ㄘㄨㄟ
D+	(雙加)	D+
D<	(雙小於)	D<

Table II.
Chinese Forth-83 Standard Words

DEPTH	深度		ア- ^ニ カ
DNEGATE	雙負值		ア ^ニ カ ^ニ 出
DROP	丟棄		カ- ^ニ カ ^ニ
DUP	重複		イ ^ニ カ ^ニ
EXECUTE	執行		出/ア- ^ニ カ
EXIT	出來		イ ^ニ カ ^ニ
FILL	填充		カ- ^ニ カ ^ニ
I		(次序)	I
J		(外序)	J
MAX	極大		カ- ^ニ カ ^ニ
MIN	極小		カ- ^ニ ア- ^ニ カ
MOD		(除餘)	MOD
NEGATE	負值		カ ^ニ 出
NOT	非反		カ ^ニ カ ^ニ
OR	或者		カ ^ニ カ ^ニ
OVER	轉疊		出 ^ニ カ ^ニ
PICK	選疊		ア ^ニ カ ^ニ
R>		(到回疊)	R>
R@		(複回疊)	R@
ROLL	混轉		カ ^ニ カ ^ニ
ROT	翻轉		カ ^ニ カ ^ニ
SWAP	對調		カ ^ニ カ ^ニ
U<		(正小於)	U<
UM*		(正混乘)	UM*
UM/MOD		(正混除餘)	UM/MOD
XOR	僅或		カ- ^ニ カ ^ニ

Device Layer

BLOCK	區段	カ ^ニ カ ^ニ
BUFFER	緩衝	カ ^ニ カ ^ニ
CR	換行	カ ^ニ カ ^ニ
EMIT	放送	カ ^ニ カ ^ニ
EXPECT	等候	カ ^ニ カ ^ニ
FLUSH	清存	カ ^ニ カ ^ニ
KEY	字鍵	カ ^ニ カ ^ニ

(Continued on next page)

SAVE-BUFFERS 存緩衝區
SPACE 空格
SPACES 空間
TYPE 印字
UPDATE 標新

ちx3、f x3、4x2、く
3x2、4x2、
3x2、4-3
-3、7、
5-2、T-3

Interpreter Layer

(換數)
#> (停換)
#S (全換)
#TIB #終入區)
, (提取)
((左括弧)
-TRAILING 去尾
, (點)
.((點括弧)
<# (始換)
>BODY >身體
>IN >入標
ABORT 結束
BASE 基數
BLK 表數
CONVERT 變換
DECIMAL 十進位
DEFINITIONS 添詞
FIND 尋找
FORGET 忘記
FORTH 福式
FORTH-83 福式 - 83
HERE 這兒
HOLD 包函
LOAD 譯入
PAD 填補區
QUIT 終止

#>
#S
#4x2、8x、く
,
(
く、x、
,
.(
<#
>7、4-
>8x、5-2
4-2、4x、
4-、7x、
5-2、7x、
5-3、7x3、
7、4-5、x、
4-3-5、
T、4、4x、
x、4-、
7x、7、
7x、7、-83
4x、
5x、7、
-、8x、
4-3、5x、く
4x2、4、

SIGN	符號		ㄘㄨㄟㄈㄨㄢ
SPAN	延申		-ㄅㄟㄈㄨ
TIB	終入區		ㄗㄨㄥㄣㄣㄣㄣㄣㄣ
U.		(正點)	U.
WORD	詞字		ㄗㄟㄆㄢ

Compiler Layer

+LOOP	+轉合		+ㄗㄨㄥㄣㄣㄣㄣㄣㄣ
,		(入位)	,
."		(示字)	."
:		(開始定美)	:
;		(定義結束)	;
ABORT"	結束"		4-ㄗㄟㄣㄣㄣㄣㄣ
ALLOT	保留		ㄗㄨㄥㄣㄣㄣㄣㄣ
BEGIN	開始		ㄗㄨㄥㄣㄣㄣㄣㄣ
COMPILE	編碼		ㄗㄨㄥㄣㄣㄣㄣㄣ
CONSTANT	常數		ㄗㄨㄥㄣㄣㄣㄣㄣ
CREATE	創造		ㄗㄨㄥㄣㄣㄣㄣㄣ
DO	起承		ㄗㄨㄥㄣㄣㄣㄣㄣ
DOES>	操作>		ㄗㄨㄥㄣㄣㄣㄣㄣ
ELSE	不然		ㄗㄨㄥㄣㄣㄣㄣㄣ
IF	假如		4-ㄗㄟㄣㄣㄣㄣㄣ
IMMEDIATE	立即		ㄗㄨㄥㄣㄣㄣㄣㄣ
LEAVE	離開		ㄗㄨㄥㄣㄣㄣㄣㄣ
LITERAL	編數		ㄗㄨㄥㄣㄣㄣㄣㄣ
LOOP	轉合		ㄗㄨㄥㄣㄣㄣㄣㄣ
REPEAT	重來		ㄗㄨㄥㄣㄣㄣㄣㄣ
STATE	狀態		ㄗㄨㄥㄣㄣㄣㄣㄣ
THEN	否則		ㄗㄨㄥㄣㄣㄣㄣㄣ
UNTIL	直到		ㄗㄨㄥㄣㄣㄣㄣㄣ
VARIABLE	變數		ㄗㄨㄥㄣㄣㄣㄣㄣ
VOCABULARY	字彙		ㄗㄨㄥㄣㄣㄣㄣㄣ
WHILE	正當		ㄗㄨㄥㄣㄣㄣㄣㄣ
[(換態)	[
[']		(立即提)	[']
[COMPILE]	[編碼]		[ㄗㄨㄥㄣㄣㄣㄣㄣ]
]		(回態)]

End Table

cc A Driver for a Small-C Programming System

Dr. Schreiner was kind enough to provide us with two programs for use with the Small-C compiler: cc, presented here, and p, a stand-alone Small-C preprocessor. References to p, in the following discussion are to that preprocessor, which we will publish next month. — Ed.

Once you make extensive use of a programming system consisting of a compiler, assembler, and linker, you find yourself either typing a lot of commands or using the CP/M SUBMIT facility quite a bit. The latter, however, is not very flexible. It will run unconditionally whatever commands the batch file dictates; those, regardless of argument substitution, may be more or less than what you intended.

A language like C encourages separate compilation and program composition from various source files. A combination like Jim Hendrix's Small-C compiler (DDJ, December 1982) and MicroSoft's relocating assembler and linking loader makes it quite attractive to compile as little as possible during program development. When you add a separate preprocessor for Small C and attempt to eliminate intermediate files, you find yourself typing a lot of (almost) identical commands each time you want to preprocess, compile, erase, assemble, erase, link, and so on.

cc (Listing One, page 44) is a program patterned after Dennis Ritchie's cc command in the Unix* system. It accepts options and file specifications and, through CP/M's SUBMIT feature, arranges for the proper amount of preprocessing, compiling, assembly, and loading. Essentially you type what files ought to be processed to construct a program, then cc prepares a SUBMIT file and persuades CP/M to execute it.

Features

cc is based on a runtime support that passes arguments to the main program. It expects to be called as follows:

by Axel Schreiner

Axel T. Schreiner, Universität Ulm, Sektion Meth. d. Informatik, Oberer Eselsberg, 7900 Ulm (Doran) West Germany.

*Unix is a trademark of Bell Laboratories.

cc (option) . . . file . . .

You may specify options in any order. They are generally cumulative. The following options are available:

-c	Compile only; do not execute the linker
-p	Preprocess only
-s	Preprocess and compile only
-o filename	Output of the linker is "filename"

Other options are passed on to the relevant processor, mostly to the Small-C preprocessor. p accepts the following:

-d name	Define a symbolic name (=value)
-e	Suppress position stamps
-i drive	Search for file inclusion
-u name	Undefine a symbolic name

So that p can be used prior to Hendrix's compiler, the -e option is included automatically.

Files are passed on to the appropriate processors. The more general files are processed first. Intermediate files, named after the original source files, are erased once they are no longer needed; objects, however, are retained. In the absence of the -o option, the resulting load module will be named after the first of the more general source files. cc uses the following filename extensions:

.c	Preprocessor source file
.i	Compiler source file
.mac	Macro assembler source file
.rel	Linker source file or library

If an extension is not present or is unrecognizable, the file is passed only to the linker. It is thus quite simple to pass libraries. Files are passed to the linker within each source file category in the order specified; the more general source file category, however, is passed first. This rarely produces conflicts.

The options are clearly patterned after the Unix system. The main program expects to receive pointers to the various options as a vector "argv." The number of such options, including (theoretically) the program name as first option, is also passed as an integer "argc." Options must precede the filenames.

Examples

A few sample calls might illustrate just what cc does. The first call will construct the cc command itself:

B>cc cc.c

On my system I have the shortest possible names for the language processors, and I keep most tools on disk a:. Here the following commands would be issued:

```
A>b:p-e b:cc.c >b:cc.i
A>c b:cc.i >b:cc.mac
A>era b:cc.i
A>m =b:cc
A>era b:cc.mac
A>l b:cc/n/e,b:cc,c/s
A>b:
```

Assume that submit.c is compiled separately:

```
B>cc -c submit.c
A>b:p -e b:submit.c >b:submit.i
A>c b:submit.i >b:submit.mac
A>era b:submit.i
A>m =b:submit
A>era b:submit.mac
A>b:
```

Subsequently we can compile cc.c and link it as follows:

```
B>cc submit cc.c
A>b:p -e b:cc.c >b:cc.i
A>c b:cc.i >b:cc.mac
A>era b:cc.i
A>m =b:cc
A>era b:cc.mac
A>l b:cc/n/e,b:cc,submit,c/s
A>b:
```

It should be clear why such a driver program might be useful not only for Small C.

Implementation

The system driver basically has the following structure:

- obtain and save options, initialize
- obtain, test, and save files
- for each category of source files run preprocessor, compiler, assembler as required
- run linker as required

Most of this is accomplished by main(); one subroutine for each processor handles the problem of issuing the actual commands. This arrangement makes the system easy to adapt to other processors.

File and option lists must be circular so that they can be traversed easily in input order. Push routines maintain the lists. A list element consists of a pointer to the next list element, followed by

the string that constitutes the actual value stored. The list header points to the last element entered, which in turn points to the first element, and the circular list continues on to the last element again. The list need not be marked since you always start at the list header and thus know when you have traversed the list once.

For reasons explained below, file-names must be fully specified. If an explicit drive name is not part of the file specification, `pushf()` will add the current drive name.

The `kind()` function analyzes a file specification to determine the source category based on the file extension. All "unknown" extensions are considered to be object specifications. This allows linker libraries to pass through correctly. All other files must be existing source files. To detect trivial errors early, `kind()` tests all source files for existence by opening them for reading.

submit()

The most interesting aspect of `cc` clearly is its use of the CP/M SUBMIT feature. During a warm start on drive `a:`, the CP/M console command processor (CCP) checks if a file `$$$sub` exists. If it does, it is expected to contain one CCP command line (preceded by its length) per CP/M sector. The CCP takes the *last* sector from the file, truncates the file by one sector, and issues the command.

To use this feature, you need to store all command lines as a stack then write them, appropriately formatted, into the file. You also need to take care that, once the driver program exits, drive `a:` is selected and a warm start is performed.

The `submit()` function (Listing Two, page 52) handles all of this. If it is called with a string argument, it will stack the string (using a dynamic memory allocation function that is part of my runtime support). If it is called with a NULL argument, it will write the stack (i.e., the commands in reverse order) into the file, force the CCP to select drive `a:` (and user area 0) by clearing the byte at location 4, and terminate program execution through a warm start.

`submit()` issues a command to (re-)select the current drive, so that once the batch stream is completely processed the current drive is selected again. Nevertheless, during batch execution, drive `a:` must be selected. This is why `pushf()` fully specifies each file.

`submit()` actually appends to the end of the batch file processed by the CCP. This has a desirable effect in that `submit()` can be used from *within* a batch stream — something that is lacking in the CP/M SUBMIT utility. (It is not very difficult to position a CP/M file to end of file, especially on a sector boundary.) A simple test program (Listing Three, page 55) demonstrates this feature:

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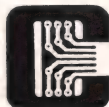
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```
B>x a 'b c' 'd e' f" g
```

```
a
A>b: x b c
b
A>b: x c
c
A>a:
A>b: x 'd e' f
d e
A>b: x f
f
A>a:
A>b: x g
g
A>b:
```

Quotes and double quotes can be used to hide white space within command arguments. The output shown above has been indented to show the nesting of batch streams.

Installation

Getting *cc* to run on your system might be tricky. Basically you need to decide where your processors and standard libraries reside and how they ought to be called. Also, *cc* relies on my own runtime support, which is heavily oriented towards the Unix environment.

You probably should consult Kernighan and Ritchie's book *The C Programming Language* (Prentice Hall, 1978) to learn about all the routines that are mentioned "extern" at the beginning of the program. Most of them are quite simple to construct. It is essential, however, that you provide a memory allocator, `calloc()`, that is reasonably stable. I am using a scheme where memory above the load module and below the stack is managed by a list of words, each word pointing to the next. The low bit in each such word indicates if the area past that word and up to the next one is allocated or free.

I have had access to Chapter 17 of Hendrix's book on Small C, describing his runtime support. [See this month and last month for Payne's and Hendrix's new library - Ed.] While I did not have access to the runtime support itself and therefore could not test it, I believe that installing *cc* should be quite simple. The following probably must be done:

```
FILE          should be defined as int.
_drive( )     needs to access BDOS function 25.
fseek( . . . , 10) is Hendrix's cseek( . . . , 2).
rindex( )     is Hendrix's strrchr( ).
```

You can replace `_bputchar()` by storing the relevant characters in a buffer of length 128 and using Hendrix's `write()` to emit the buffer. The file pointer `_cfp` then is not needed.

I process the arguments to `main()` directly. Depending on the actual implementation, you might have to use Hendrix's function `getarg()`. I am assuming

that the storage allocator, `calloc()/cfree()`, supports random order release of memory.

Two runtime routines deserve special mention:

```
fseek(fp, 0, 10)
```

will position the file indicated by "fp" to the end of the last allocated CP/M sector. (In Unix the third argument for `fseek()` must be 0, 1, or 2, indicating positioning relative to the beginning of the file, the present position, and the end of the file. Additionally, I permit 8, 9, and 10, indicating sector positioning.)

```
_bputchar(ch)
```

will emit the character "ch" to the file currently indicated by `"_cfp"` without interpreting tab, return, or other characters. Since `submit()` must write CP/M sectors containing binary length information, use of this very internal routine of the runtime support is necessary. `_bputchar()` returns EOF on end of file, e.g., when the relevant disk overflows.

Deciding where your processors live and how they ought to be called is your own problem. I have a CP/M system with two 200K floppies; one of these (barely) contains Small C, the MicroSoft assembler and linker, a text editor, and my runtime library. Unless I trade the text editor for the preprocessor, I have to call the preprocessor from the second disk.

Notice that the SUBMIT file must be on the a: disk and that this disk must be selected while this file is processed. My processors therefore all sit on this disk, with enough room left over for the SUBMIT file.

Constructing the proper calls is relatively simple; if you use other systems, you may have to add a small amount of code to the program.

Part of this work was done during a sabbatical spent at the University of Illinois; in particular, the Small-C system was obtained from "UseNet."

■■■

(Listing begins on page 44)

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Listing One

```
/*
 *      cc - smallC compiler driver
 *      ats 5/83
 */

/*
 *      define...
 *
 *      c80      to drive Software Toolworks C80
 */

char      usage[] =
    "cc [-c|p|s] [-d n[=v]] [-e] [-i d:] [-o task] [-u n] files";

#define Csource 1          /* results of kind() */
#define Msource 2
#define Psource 3

#define Cfile      ".i"      /* for these extensions */
#define Pfile      ".c"
#define Mfile      ".mac"

#define C          "c"      /* for these processors */
#define P          "b:p"
#define M          "m"
#define L          "l"

#define CLIB       "c/s"    /* and this library search */

/*
 *      "FEATURES:"
 *
 *      If the same file name is specified with different
 *      extensions, the most general source is processed...
 *      ...and the others will fail, but be linked several times!
 */

#include <stdio.h>

/*
 *      i/o header file

#define FILE      ???      type to represent files (used as FILE*)
#define stdin     ???      pre-opened standard input file
#define stdout    ???      pre-opened standard output file
#define stderr    ???      pre-opened diagnostic output file
#define NULL      0        null pointer, false
#define EOF       ???      end of file indication

 */

/*
 *      special data type

#define LIST      int      /* list of word or string values */

#define l_next(x)  (*(x))    /* -> next element */
#define l_str(x)   ((x)+1)   /* -> string value */
#define l_first(x) (*(x)+2)  /* -> first string value in circular list */
#define sz_STR(s)  (3+strlen(s)) /* size of string list element */
#define sz_FILE(s) (5+strlen(s)) /* size of file (+ drive) element */
```

```

/*
 * runtime support routines
 */

extern _drive(), /* BDOS function 25: current drive number */
calloc(), /* (n,l) return NULL or -> n elements of length l */
cfree(), /* (p) free area at p, returned by calloc() */
exit(), /* terminate program execution */
fputs(), /* (s,f) write string s on file f */
freopen(), /* (n,m,f) return NULL or file descriptor f,
            closed if necessary, and reopened to read
            (m == "r"), write ("w"), or append ("a") */

rindex(), /* (s,c) find c in string s end to front, return
            NULL or ->c in s; '\0' is always found */

strcat(), /* (a,b) copy string b beyond string a */
strcmp(), /* (a,b) (<, ==, >) 0 as string a is (<, ==, >) string b */
strcpy(), /* (a,b) copy string b to string a */
strlen(), /* (s) return number of characters in string s */
submit(); /* (s) add string s to command list; (NULL) submit */

/*
 * global data
 */

char buf[126], /* to submit (length unchecked...) */
drive[] = "?:", /* current drive name */
pflag, /* run only preprocessor */
cflag, /* run only compiler */
sflag; /* run assembler */

LIST *task, /* task name (-o option) only */
*popt, /* p option list */
*parg, /* p argument list */
*carg, /* c argument list */
*marg, /* m argument list */
*larg; /* l argument list */

main(argc, argv)
int argc;
int *argv;
{
    char *cp;
    LIST *arg;

    /* remember current drive */
    drive[0] = _drive() + 'a';

    /* default preprocessor options */
    pop = pushes(pop, "-e");

    /* record options and flags */
    while (--argc)
    {
        cp = *++argv;
        /* options must precede files */
        if (*cp != '-')
            break;
        /* dispatch and record, accept values attached or separate */
        switch(cp[1]) {
            case 'c': /* -c run p c m */
                cflag = 1;
                break;
            case 'd': /* -d n[=v] p option */
            case 'i': /* -i d: p option */
            case 'u': /* -u n p option */
                pop = pushes(pop, *argv);
                if (cp[2])
                    break;
        }
    }
}

```

(Continued on next page)

Listing One

```

        if (--argc == 0)
            goto error;
        popt = pushs(popt, *++argv);
        break;
    case 'e':
        /* -e          p option */
        popt = pushs(popt, *argv);
        break;
    case 'o':
        /* -o task      name task image */
        if (cp[2])
            task = pushf(task, cp+2);
        else if (--argc == 0)
            goto error;
        else
            task = pushf(task, *++argv);
        break;
    case 'p':
        /* -p          run p */
        pflag = 1;
        break;
    case 's':
        /* -s          run p c */
        sflag = 1;
        break;
    default:
        goto error;
}

}

/* there must be at least one file */
if (argc == 0)
{
error:    fputs(usage, stderr);
        exit();
}

/* collect files on various lists */
do
{
    switch(kind(*argv)) {
    case Psource:
        parg = pushf(parg, *argv);
        break;
    case Csource:
        carg = pushf(carg, *argv);
        break;
    case Msource:
        marg = pushf(marg, *argv);
        break;
    default:
        larg = pushf(larg, *argv);
    }
    ++argv;
} while (--argc);

/* run files preprocessor -> compiler -> assembler */
if (arg = parg)
do
{
    arg = *arg;
    run(P, popt, l_str(arg), Pfile, Cfile);
    if (pflag)
        continue;
    run(C, NULL, l_str(arg), Cfile, Mfile);
    erase(l_str(arg), Cfile);
}

```

(Continued on page 48)

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Listing One

```
        if (sflag)
            continue;
        asm(l_str(arg));
        erase(l_str(arg), Mfile);
    } while (arg != parg);
if (pflag)
    goto done;

/* run files compiler -> assembler */
if (arg = carg)
    do
    {
        arg = *arg;
        run(C, NULL, l_str(arg), Cfile, Mfile);
        if (sflag)
            continue;
        asm(l_str(arg));
        erase(l_str(arg), Mfile);
    } while (arg != carg);
if (sflag)
    goto done;

/* run files assembler */
if (arg = marg)
    do
    {
        arg = *arg;
        asm(l_str(arg));
    } while (arg != marg);
if (cflag)
    goto done;

/* run (Microsoft) linker */
/* L task/n/e, parg..., carg..., marg..., larg..., CLIB */
/* note that we do not explicitly check the length of this command */

strcpy(buf, L);
strcat(buf, " ");

/* decide on output file name */
if (task)
    strcat(buf, l_str(task));
else if (parg)
    strcat(buf, l_first(parg));
else if (carg)
    strcat(buf, l_first(carg));
else if (marg)
    strcat(buf, l_first(marg));
else if (larg)
    strcat(buf, l_first(larg));
else
{
    strcat(buf, drive);
    strcat(buf, "task");
}
strcat(buf, "/n/e");

/* add all modules */
if (arg = parg)
    do
    {
        arg = *arg;
        strcat(buf, ",");
        strcat(buf, l_str(arg));
    } while (arg != parg);
```

```

if (arg = carg)
do
{
    arg = *arg;
    strcat(buf, ",");
    strcat(buf, l_str(arg));
} while (arg != carg);
if (arg = marg)
do
{
    arg = *arg;
    strcat(buf, ",");
    strcat(buf, l_str(arg));
} while (arg != marg);
if (arg = larg)
do
{
    arg = *arg;
    strcat(buf, ",");
    strcat(buf, l_str(arg));
} while (arg != larg);

/* add smallC library and submit */
strcat(buf, ",");
strcat(buf, CLIB);
submit(buf);

/* submit the batch stream */
done:
submit(NULL);
}

/*
 * circular list routines
 */

pushs(l, s)                /* attach string to list */
LIST *l;                   /* list */
char *s;                   /* string */
{
    LIST *r;               /* new element */

    if ((r = calloc(sz_STR(s), 1)) == NULL)
    {
        fputs("no room", stderr);
        exit();
    }
    strcpy(l_str(r), s);
    /* empty list: link first element to itself */
    if (l == NULL)
        return l_next(r) = r;
    /* nonempty list: tie element into it */
    l_next(r) = l_next(l);
    return l_next(l) = r;
}

pushf(l, f)                /* attach file name to list */
LIST *l;                   /* list */
char *f;                   /* file name */
{
    LIST *r;               /* new element */

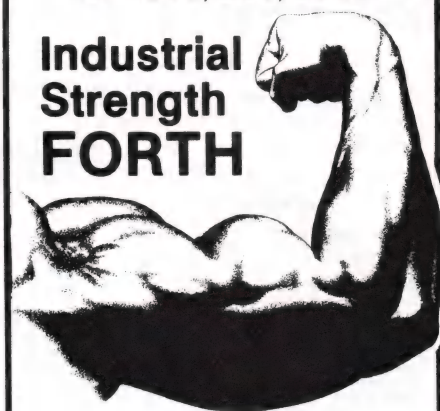
    if ((r = calloc(sz_FILE(f), 1)) == NULL)
    {
        fputs("no room", stderr);
        exit();
    }
    if (f[1] != ':')        /* use current drive */
    {
        strcpy(l_str(r), drive);
        strcat(l_str(r), f);
    }
    else
        /* explicit drive */

```

(Continued on next page)

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Listing One

```

        strcpy(l_str(r), f);
    if (l == NULL)
        return l_next(r) = r;
    l_next(r) = l_next(l);
    return l_next(l) = r;
}

/*
 *   source file type analysis
 */

kind(f)                /* determine type of source */
char *f;                /* file name */
char *p;
{
    if (p = rindex(f, '.'))
        if (strcmp(p, Pfile) == 0)
        {
            if (freopen(f, "r", stdin) == NULL)
                goto badfile;
            *p = '\0';
            return Psource;
        }
        else if (strcmp(p, Cfile) == 0)
        {
            if (freopen(f, "r", stdin) == NULL)
                goto badfile;
            *p = '\0';
            return Csource;
        }
        else if (strcmp(p, Mfile) == 0)
        {
            if (freopen(f, "r", stdin) == NULL)
                goto badfile;
            *p = '\0';
            return Msource;
        }
    return 0;
}

badfile:
    fputs("cannot open ", stderr);
    fputs(f, stderr);
    exit();
}

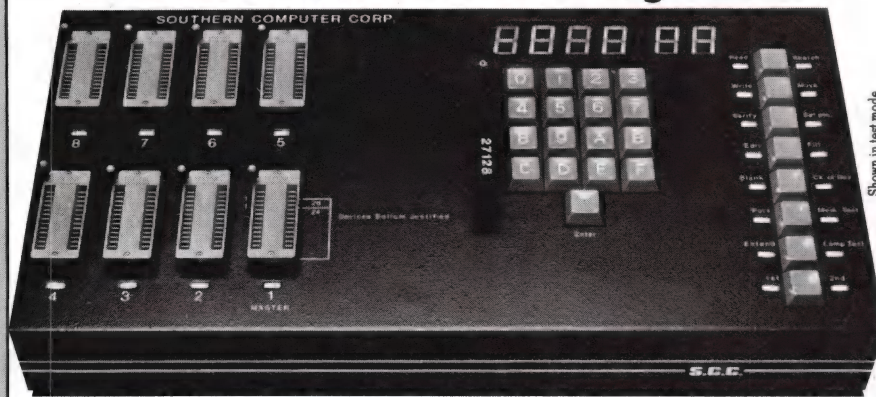
/*
 *   routines to produce command calls
 */

run(cmd, opt, fnm, in, out)    /* run smallC task */
                                /* cmd opt... fnm.in > fnm.out */
char *cmd;                    /* command name */
LIST *opt;                    /* option list */
char *fnm;                    /* file name to process */
char *in;                     /* input file extension */
char *out;                    /* output file extension */
LIST *p;
{
    strcpy(buf, cmd);
    if (p = opt)
        do
        {
            p = l_next(p);
            strcat(buf, " ");
            strcat(buf, l_str(p));
        }

```

(Continued on page 52)

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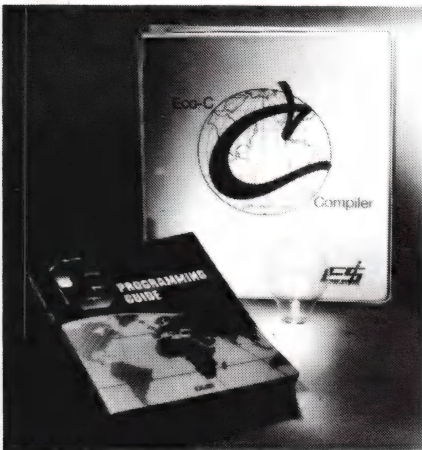
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Listing One

```
        } while (p != opt);
        strcat(buf, " ");
        strcat(buf, fnm);
#ifdef c80
        strcat(buf, in);
        strcat(buf, " >");
        strcat(buf, fnm);
        strcat(buf, out);
#endif
        submit(buf);
    }

asm(fnm)                /* run (Microsoft) macro assembler */
                        /* M = fnm */
    char *fnm;          /* file name to process */
{
    strcpy(buf, M);
    strcat(buf, " =");
    strcat(buf, fnm);
    submit(buf);
}

erase(fnm,ext)          /* erase intermediate file */
                        /* era fnm.ext */
    char *fnm;          /* file name */
    char *ext;          /* extension */
{
    strcpy(buf, "era ");
    strcat(buf, fnm);
    strcat(buf, ext);
    submit(buf);
}
```

End Listing One

Listing Two

```
/*
 *      submit() -- submit commands to CP/M batch
 *      ats 5/83
 */

#define DSKBYTE 4        /* BDOS/CCP selected disk, user# */

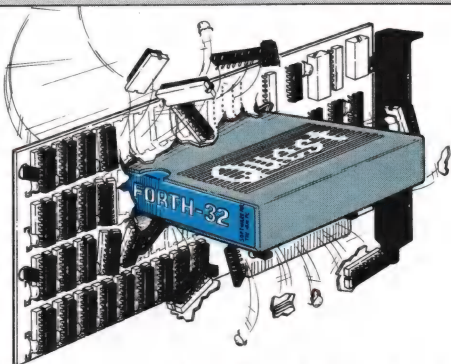
/*
 *      needed from the i/o header file

#define FILE      ???     type to represent files
#define NULL      0       null pointer, false
#define EOF       ???     end of file indication

 */

/*
 *      runtime support routines
 */
```

(Continued on page 54)



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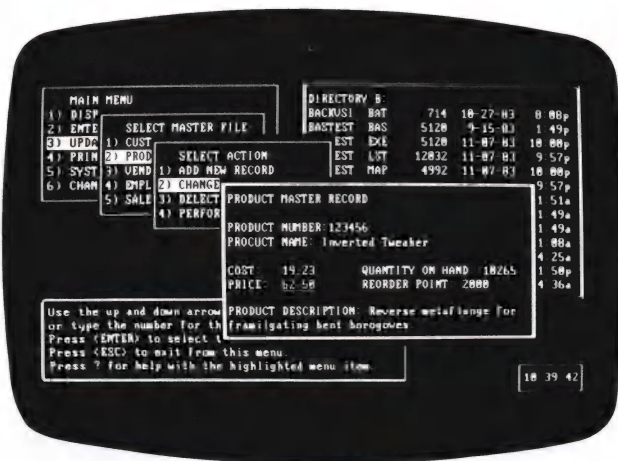
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Listing Two

```

extern  _bputchar(),      /* (c) write char c uninterpreted to FILE *_cfp */
        _cfp,
        _drive(),        /* BDOS function 25: current drive number */
        calloc(),        /* (n,l) return NULL or -> n elements of length l */
        exit(),          /* terminate program execution */
        fclose(),        /* (f) close file described by f */
        fopen(),         /* (n,m) return NULL or descriptor for file "n"
                        opened to append (m == "a") */
        fseek(),         /* (f,p,w) position f to byte or sector p measured
                        according to w */
        strcpy(),        /* (a,b) copy string b to string a */
        strlen();        /* (s) return number of characters in string s */

/*
 *   global data
 */

int *_submit;            /* stack of submitted buffers */

submit(s)                /* add command to CP/M job stream */
                        /* returns argument or NULL */
                        /* on NULL argument: submits and exits */
{
    char * s;            /* command to submit */
    FILE *fp;            /* need to use block i/o, NOT putc */
    char *cp;
    int *wp, i;

    /* if string argument, save it as a command */
    if (s)
    {
        if (strlen(s) > 126)
            return NULL;    /* too long */
        if ((wp = calloc(strlen(s)+2+2,1)) == NULL)
            return NULL;    /* no room */
        *wp = _submit;
        _submit = wp;
        cp = _submit+1;

        *cp = strlen(s);    /* length byte */
        strcpy(cp+1, s);    /* text */
        return s;
    }

    /* if anything to submit - write it to a:$$$sub */
    if (_submit)
    {
        if ((fp = fopen("a:$$$sub", "a")) == NULL)
            return NULL;    /* cannot make batch file */
        if (fseek(fp, 0, 10) == -1)
            goto error;
        _cfp = fp;        /* for _bputchar() */

        /* last command: reselect current drive */
        _bputchar(2);
        _bputchar(_drive()+ 'a');
        _bputchar(' ');
        for (i = 3; i < 127; ++i)
            _bputchar(0);
        /* check last byte in sector for overflow */
        if (_bputchar(0))
            goto error;

        /* other commands from stack */
        do

```

```

        {
            cp = _submit+1;
            for (i = 0; i < 127; ++i)
            {
                _bputchar(*cp);
                if (*cp)
                    ++cp;
            }
            if (_bputchar(*cp) == EOF)
            {
error:                fclose(fp);
                        return NULL;    /* overflow */
            }
        } while (_submit = *_submit);

        /* signal CCP to select a: and user 0 */
        cp = DSKBYTE;
        *cp = 0;
    }

    /* exit this program and perform warm start */
    exit();
}

```

End Listing Two

Listing Three

```

#include <stdio.h>
extern strcpy(), strcat(), submit(), puts();

main(argc, argv)
    int argc;
    int *argv;
{
    int i;
    char buf[128];

    switch (argc) {
    default:
        strcpy(buf, "b:x ");
        for (i=2; i<argc; ++i)
        {
            strcat(buf+4, argv[i]);
            submit(buf);
        }
    case 2:
        puts(argv[1]);
    case 1:
        ;
    }
    if (submit(NULL) == NULL)
        puts("oops");
}

```

End Listing Three

A New Library for Small-C (Part II)

In December 1982 and January 1983 we presented version 2.0 of the Small-C compiler by James Hendrix. Last month Hendrix and Ernest Payne presented their enhanced library for the compiler, as well as code which upgrades the compiler to version 2.1. This month completes the listing of the library. —Ed.

Small-C Library Listing Two

(Continued from May issue page 81)

File: FSCANF.C

```
1 #define NOCCARGC /* no argument count passing */
2 /*
3 ** Yes, that is correct. Although these functions use an
4 ** argument count, they do not call functions which need one.
5 */
6 #include stdio.h
7 /*
8 ** fscanf(fd, ctlstring, arg, arg, ...) - Formatted read.
9 ** Operates as described by Kernighan & Ritchie.
10 ** b, c, d, o, s, u, and x specifications are supported.
11 ** Note: b (binary) is a non-standard extension.
12 */
13 fscanf(argc) int argc; {
14     int *nxtarg;
15     nxtarg = CCARGC() + &argc;
16     return (_scan(*(--nxtarg), --nxtarg));
17 }
18
19 /*
20 ** scanf(ctlstring, arg, arg, ...) - Formatted read.
21 ** Operates as described by Kernighan & Ritchie.
22 ** b, c, d, o, s, u, and x specifications are supported.
23 ** Note: b (binary) is a non-standard extension.
24 */
25 scanf(argc) int argc; {
26     return (_scan(stdin, CCARGC() + &argc - 1));
27 }
28
29 /*
30 ** _scan(fd, ctlstring, arg, arg, ...) - Formatted read.
```

by James Hendrix and Ernest Payne

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```
31 ** Called by fscanf() and scanf().
32 */
33 _scan(fd, nxtarg) int fd, *nxtarg; {
34     char *carg, *ctl, *unsigned;
35     int *narg, wast, ac, width, ch, cnv, base, ovfl, sign;
36     ac = 0;
37     ctl = *nxtarg--;
38     while(*ctl) {
39         if(isspace(*ctl)) {++ctl; continue;}
40         if(*ctl++ != '%') continue;
41         if(*ctl == '%') {narg = carg = &wast; ++ctl;}
42         else narg = carg = *nxtarg--;
43         ctl += utoi(ctl, &width);
44         if(!width) width = 32767;
45         if(!(cnv = *ctl++)) break;
46         while(isspace(ch = fgetc(fd))) ;
47         if(ch == EOF) {if(ac) break; else return(EOF);}
48         ungetc(ch, fd);
49         switch(cnv) {
50             case 'c':
51                 *carg = fgetc(fd);
52                 break;
53             case 's':
54                 while(width--) {
55                     if(*carg = fgetc(fd)) == EOF) break;
56                     if(isspace(*carg)) break;
57                     if(carg != &wast) ++carg;
58                 }
59                 *carg = 0;
60                 break;
61             default:
62                 switch(cnv) {
63                     case 'b': base = 2; sign = 1; ovfl = 32767; break;
64                     case 'd': base = 10; sign = 0; ovfl = 3276; break;
65                     case 'o': base = 8; sign = 1; ovfl = 8191; break;
66                     case 'u': base = 10; sign = 1; ovfl = 6553; break;
67                     case 'x': base = 16; sign = 1; ovfl = 4095; break;
68                     default: return (ac);
69                 }
70                 *narg = unsigned = 0;
71                 while(width-- && !isspace(ch=fgetc(fd)) && ch!=EOF) {
72                     if(!sign)
73                         if(ch == '-') {sign = -1; continue;}
74                         else sign = 1;
75                     if(ch < '0') return (ac);
76                     if(ch >= 'a') ch -= 87;
77                     else if(ch >= 'A') ch -= 55;
78                     else ch -= '0';
79                     if(ch >= base || unsigned > ovfl) return (ac);
80                     unsigned = unsigned * base + ch;
81                 }
82                 *narg = sign * unsigned;
83             }
84         ++ac;
85     }
```

```

86 return (ac);
87 }
88

```

File: FWRITE.C

```

1 #define NOCCARGC /* no argument count passing */
2 #include clib.def
3 extern int _status[];
4 /*
5 ** Item-stream write to fd.
6 ** Entry: buf = address of source buffer
7 **          sz = size of items in bytes
8 **          n = number of items to write
9 **          fd = file descriptor
10 ** Returns a count of the items actually written or
11 ** zero if an error occurred.
12 ** May use ferror(), as always, to detect errors.
13 */
14 fwrite(buf, sz, n, fd) char *buf; int sz, n, fd; {
15     int cnt;
16     if((cnt = write(fd, buf, n*sz)) == -1) return (0);
17     return (cnt);
18 }
19
20 /*
21 ** Binary-stream write to fd.
22 ** Entry: fd = file descriptor
23 **          buf = address of source buffer
24 **          n = number of bytes to write
25 ** Returns a count of the bytes actually written or
26 ** -1 if an error occurred.
27 ** May use ferror(), as always, to detect errors.
28 */
29 write(fd, buf, n) int fd, n; char *buf; {
30     char *cnt; /* fake unsigned */
31     cnt = 0;
32     while(n--) {
33         _write(buf++, fd);
34         if(_status[fd] & ERFBIT) return (-1);
35         ++cnt;
36     }
37     return (cnt);
38 }

```

File: GETARG.C

```

1 #define NOCCARGC /* no argument count passing */
2 #include stdio.h
3 /*
4 ** Get command line argument.
5 ** Entry: n = Number of the argument.
6 **          s = Destination string pointer.
7 **          size = Size of destination string.
8 **          argc = Argument count from main().
9 **          argv = Argument vector(s) from main().
10 ** Returns number of characters moved on success,
11 ** else EOF.
12 */
13 getarg(n,s,size,argc,argv)
14 int n; char *s; int size, argc, argv[]; {
15     char *str;

```

```

16 int i;
17 if(n < 0 || n >= argc) {
18     *s = NULL;
19     return EOF;
20 }
21 i = 0;
22 str=argv[n];
23 while(i<size) {
24     if((s[i]=str[i])!=NULL) break;
25     ++i;
26 }
27 s[i]=NULL;
28 return i;
29 }

```

File: GETCHAR.C

```

1 #define NOCCARGC /* no argument count passing */
2 #include stdio.h
3 /*
4 ** Get next character from standard input.
5 */
6 getchar() {
7     return (fgetc(stdin));
8 }

```

File: ISALNUM.C

```

1 /*
2 ** return 'true' if c is alphanumeric
3 */
4 isalnum(c) int c; {
5     return ((c<='z' && c>='a') ||
6             (c<='Z' && c>='A') ||
7             (c<='9' && c>='0'));
8 }

```

File: ISALPHA.C

```

1 /*
2 ** return 'true' if c is alphabetic
3 */
4 isalpha(c) int c; {
5     return ((c<='z' && c>='a') || (c<='Z' && c>='A'));
6 }

```

File: ISASCII.C

```

1 /*
2 ** return 'true' if c is an ASCII character (0-127)
3 */
4 isascii(c) char *c; {
5     /* c is a simulated unsigned integer */
6     return (c <= 127);
7 }

```

File: ISATTY.C

```

1 extern int _device[];
2 /*
3 ** Return "true" if fd is a device, else "false"

```

(Continued on next page)

Small-C Library (Listing Continued)

Listing Two

```
4 */
5 isatty(fd) int fd; {
6     return (_device[fd]);
7 }
```

File: ISCNTRL.C

```
1 /*
2 ** return 'true' if c is a control character
3 ** (0-31 or 127)
4 */
5 iscntrl(c) char *c; {
6     /* c is a simulated unsigned integer */
7     return ((c <= 31) || (c == 127));
8 }
```

File: ISCONS.C

```
1 #include stdio.h
2 #include clib.def
3 extern int _device[];
4 /*
5 ** Determine if fd is the console.
6 */
7 iscons(fd) int fd; {
8     return (_device[fd] == CPMCON);
9 }
```

File: ISDIGIT.C

```
1 /*
2 ** return 'true' if c is a decimal digit
3 */
4 isdigit(c) int c; {
5     return (c <= '9' && c >= '0');
6 }
```

File: ISGRAPH.C

```
1 /*
2 ** return 'true' if c is a graphic character
3 ** (33-126)
4 */
5 isgraph(c) int c; {
6     return (c >= 33 && c <= 126);
7 }
```

File: ISLOWER.C

```
1 /*
2 ** return 'true' if c is lower-case alphabetic
```

```
3 */
4 islower(c) int c; {
5     return (c <= 'z' && c >= 'a');
6 }
```

File: ISPRINT.C

```
1 /*
2 ** return 'true' if c is a printable character
3 ** (32-126)
4 */
5 isprint(c) int c; {
6     return (c >= 32 && c <= 126);
7 }
```

File: ISPUNCT.C

```
1 #define NOCCARBC /* no argument count passing */
2 /*
3 ** return 'true' if c is a punctuation character
4 ** (all but control and alphanumeric)
5 */
6 ispunct(c) int c; {
7     return (!isalnum(c) && !iscntrl(c));
8 }
```

File: ISSPACE.C

```
1 /*
2 ** return 'true' if c is a white-space character
3 */
4 isspace(c) int c; {
5     /* first check gives quick exit in most cases */
6     return (c <= ' ' && (c == ' ' || (c <= 13 && c >= 9)));
7 }
8
```

File: ISUPPER.C

```
1 /*
2 ** return 'true' if c is upper-case alphabetic
3 */
4 isupper(c) int c; {
5     return (c <= 'Z' && c >= 'A');
6 }
```

File: ISXDIGIT.C

```
1 /*
2 ** return 'true' if c is a hexadecimal digit
3 ** (0-9, A-F, or a-f)
```

(Continued on page 60)

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Small-C Library (Listing Continued)

Listing Two

```
4 */
5 isxdigit(c) int c; {
6     return ((c<='f' && c>='a') ||
7             (c<='F' && c>='A') ||
8             (c<='9' && c>='0'));
9 }
```

File: ITOA.C

```
1 #define NOCCARGC /* no argument count passing */
2 /*
3 ** itoa(n,s) - Convert n to characters in s
4 */
5 itoa(n, s) char *s; int n; {
6     int sign;
7     char *ptr;
8     ptr = s;
9     if ((sign = n) < 0) /* record sign */
10        n = -n; /* make n positive */
11     do { /* generate digits in reverse order */
12         *ptr++ = n % 10 + '0'; /* get next digit */
13     } while ((n = n / 10) > 0); /* delete it */
14     if (sign < 0) *ptr++ = '-';
15     *ptr = '\0';
16     reverse(s);
17 }
```

File: ITOAB.C

```
1 #define NOCCARGC /* no argument count passing */
2 /*
3 ** itoab(n,s,b) - Convert "unsigned" n to characters in s
4                     using base b.
5 **
6                     NOTE: This is a non-standard function.
7 */
8 itoab(n, s, b) int n; char *s; int b; {
9     char *ptr;
10    int lowbit;
11    ptr = s;
12    b >>= 1;
13    do {
14        lowbit = n & 1;
15        n = (n >> 1) & 32767;
16        *ptr = ((n % b) << 1) + lowbit;
17        if (*ptr < 10) *ptr += '0'; else *ptr += 55;
18        ++ptr;
19    } while (n != b);
20    *ptr = 0;
21    reverse(s);
22 }
```

File: ITOD.C

```
1 #include stdio.h
```

```
2 /*
3 ** itod -- convert nbr to signed decimal string of width sz
4 **         right adjusted, blank filled; returns str
5 **
6 **         if sz > 0 terminate with null byte
7 **         if sz = 0 find end of string
8 **         if sz < 0 use last byte for data
9 */
10 itod(nbr, str, sz) int nbr; char str[]; int sz; {
11     char sgn;
12     if (nbr < 0) {nbr = -nbr; sgn='-';}
13     else sgn=' ';
14     if (sz > 0) str[--sz]=NULL;
15     else if (sz < 0) sz = -sz;
16     else while (str[sz] != NULL) ++sz;
17     while (sz) {
18         str[--sz] = (nbr % 10 + '0');
19         if ((nbr = nbr / 10) == 0) break;
20     }
21     if (sz) str[--sz] = sgn;
22     while (sz > 0) str[--sz] = ' ';
23     return str;
24 }
```

File: ITOD.C

```
1 /*
2 ** itoo -- converts nbr to octal string of length sz
3 **         right adjusted and blank filled, returns str
4 **
5 **         if sz > 0 terminate with null byte
6 **         if sz = 0 find end of string
7 **         if sz < 0 use last byte for data
8 */
9 itoo(nbr, str, sz) int nbr; char str[]; int sz; {
10     int digit;
11     if (sz > 0) str[--sz]=0;
12     else if (sz < 0) sz = -sz;
13     else while (str[sz] != 0) ++sz;
14     while (sz) {
15         digit = nbr & 7; nbr = (nbr >> 3) & 8191;
16         str[--sz] = digit + 48;
17         if (nbr == 0) break;
18     }
19     while (sz) str[--sz] = ' ';
20     return str;
21 }
```

File: ITOU.C

```
1 #include stdio.h
2 /*
3 ** itou -- convert nbr to unsigned decimal string of width sz
```

(Continued on page 62)

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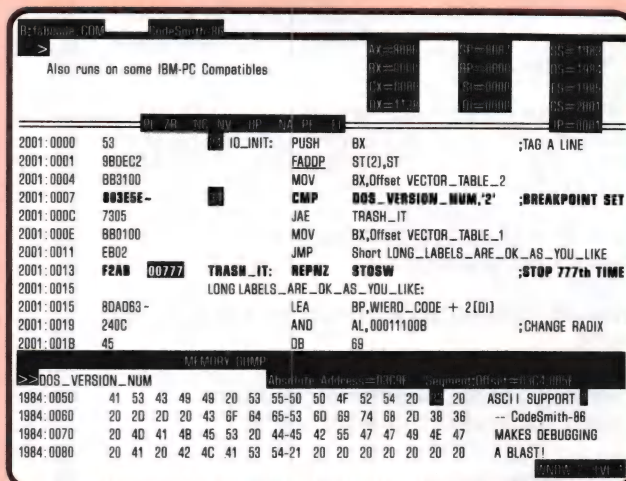
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Small-C Library (Listing Continued) Listing Two

```
4 **      right adjusted, blank filled; returns str
5 **
6 **      if sz > 0 terminate with null byte
7 **      if sz = 0 find end of string
8 **      if sz < 0 use last byte for data
9 */
10 itou(nbr, str, sz) int nbr; char str[]; int sz; {
11     int lowbit;
12     if(sz>0) str[--sz]=NULL;
13     else if(sz<0) sz = -sz;
14     else while(str[sz]!=NULL) ++sz;
15     while(sz) {
16         lowbit=nbr&1;
17         nbr=(nbr>>1)&32767; /* divide by 2 */
18         str[--sz]=((nbr%5)<<1)+lowbit+'0';
19         if((nbr=nbr/5)==0) break;
20     }
21     while(sz) str[--sz]=' ';
22     return str;
23 }
```

File: ITOX.C

```
1 /*
2 ** itox -- converts nbr to hex string of length sz
3 **      right adjusted and blank filled, returns str
4 **
5 **      if sz > 0 terminate with null byte
6 **      if sz = 0 find end of string
7 **      if sz < 0 use last byte for data
8 */
9 itox(nbr, str, sz) int nbr; char str[]; int sz; {
10     int digit, offset;
11     if(sz>0) str[--sz]=0;
12     else if(sz<0) sz = -sz;
13     else while(str[sz]!=0) ++sz;
14     while(sz) {
15         digit=nbr&15; nbr=(nbr>>4)&4095;
16         if(digit<10) offset=48; else offset=55;
17         str[--sz]=digit+offset;
18         if(nbr==0) break;
19     }
20     while(sz) str[--sz]=' ';
21     return str;
22 }
```

File: LEFT.C

```
1 /*
2 ** left -- left adjust and null terminate a string
3 */
4 left(str) char *str; {
5     char *str2;
6     str2=str;
7     while(*str2==' ') ++str2;
8     while(*str++ = *str2++);
9 }
```

File: LEXCMP.C

```
1 #define NOCCARGC /* no argument count passing */
2 /*
3 ** lexcmp(s, t) - Return a number <0, 0, or>0
4 **           as s is <, =, or > t.
5 */
6 lexcmp(s, t) char *s, *t; {
7     while(*s == *t) {
8         if(*s == 0) return (0);
9         ++s; ++t;
10    }
11    return (lexorder(*s, *t));
12 }
13
14 /*
15 ** lexorder(c1, c2)
16 **
17 ** Return a negative, zero, or positive number if
18 ** c1 is less than, equal to, or greater than c2,
19 ** based on a lexicographical (dictionary order)
20 ** colating sequence.
21 **
22 */
23 char _lex[128] = (
24     /**** NUL - / ****/
25     000,001,002,003,004,005,006,007,008,009,
26     010,011,012,013,014,015,016,017,018,019,
27     020,021,022,023,024,025,026,027,028,029,
28     030,031,032,033,034,035,036,037,038,039,
29     040,041,042,043,044,045,046,047,
30     /**** 0-9 ****/
31     065,066,067,068,069,070,071,072,073,074,
32     /**** : ; < = > ? @ ****/
33     048,049,050,051,052,053,054,
34     /**** A-Z ****/
35     075,076,077,078,079,080,081,082,083,084,085,086,087,
36     088,089,090,091,092,093,094,095,096,097,098,099,100,
37     /**** [ \ ] ^ _ ` ****/
38     055,056,057,058,059,060,
39     /**** a-z ****/
40     075,076,077,078,079,080,081,082,083,084,085,086,087,
41     088,089,090,091,092,093,094,095,096,097,098,099,100,
42     /**** { | } ~ ****/
43     061,062,063,064,
44     /**** DEL ****/
45     101
46 );
47
48 lexorder(c1, c2) char c1, c2; {
49     return(_lex[c1] - _lex[c2]);
50 }
```

File: MALLOC.C

```
1 #define NOCCARGC /* no argument count passing */
2 #include stdio.h
3 /*
4 ** Memory allocation of size bytes.
5 ** size = Size of the block in bytes.
6 ** Returns the address of the allocated block,
7 ** else NULL for failure.
```

(Continued on next page)

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Small-C Library (Listing Continued)

Listing Two

```
8 */
9 malloc(size) char *size; {
10 return (_alloc(size, NO));
11 }
```

File: OTOI.C

```
1 #include <stdio.h>
2 /*
3 ** atoi -- convert unsigned octal string to integer nbr
4 **      returns field size, else ERR on error
5 */
6 otoi(octstr, nbr) char *octstr; int *nbr; {
7 int d,t; d=0;
8 *nbr=0;
9 while((!octstr=='0')&(!octstr=='7')) {
10 t=*nbr;
11 t=(t<<3) + (*octstr++ - '0');
12 if ((t>=0)&(*nbr<0)) return ERR;
13 d++; *nbr=t;
14 }
15 return d;
16 }
```

File: PAD.C

```
1 #define NOCCARGC /* no argument count passing */
2 /*
3 ** Place n occurrences of ch at dest.
4 */
5 pad(dest, ch, n) char *dest, *n; int ch; {
6 /* n is a fake unsigned integer */
7 while(n-->0) *dest++ = ch;
8 }
```

File: POLL.C

```
1 #define NOCCARGC /* no argument count passing */
2 #include <stdio.h>
3 #include <clib.def>
4 /*
5 ** Poll for console input or interruption
6 */
7 poll(pause) int pause; {
8 int i;
9 i = _bdos(DCONIO, 255);
10 if(pause) {
11 if(i == PAUSE) {
12 while(!i = _bdos(DCONIO, 255));
13 if(i == ABORT) exit(0);
14 return (0);
15 }
16 if(i == ABORT) exit(0);
17 }
18 return (i);
19 }
```

File: PUTCHAR.C

```
1 #define NOCCARGC /* no argument count passing */
2 #include <stdio.h>
3 /*
4 ** Write character to standard output.
5 */
6 putchar(ch) int ch; {
7 return (fputc(ch, stdout));
8 }
```

File: PUTS.C

```
1 #define NOCCARGC /* no argument count passing */
2 #include <stdio.h>
3 /*
4 ** Write string to standard output.
5 */
6 puts(string) char *string; {
7 fputs(string, stdout);
8 fputc('\n', stdout);
9 }
```

File: RENAME.C

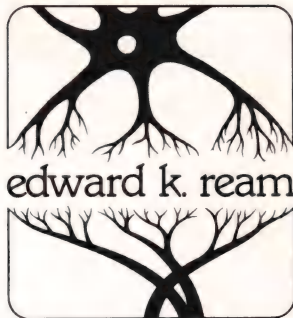
```
1 #define NOCCARGC /* no argument count passing */
2 #include <stdio.h>
3 #include <clib.def>
4 /*
5 ** Rename a file.
6 ** from = address of old filename.
7 ** to = address of new filename.
8 ** Returns NULL on success, else ERR.
9 */
10 rename(from, to) char *from, *to; {
11 char fcb[FCBSIZE];
12 pad(fcb, NULL, FCBSIZE);
13 if(!_newfcb(to, fcb) || _bdos(OPNFIL, fcb) != 255) {
14 _bdos(CLOFIL, fcb);
15 return (ERR);
16 }
17 if(!_newfcb(from, fcb) &&
18 _newfcb(to, fcb+NAMEOFF2) &&
19 _bdos(RENAME, fcb) != 255)
20 return (NULL);
21 return (ERR);
22 }
```

File: REVERSE.C

```
1 #define NOCCARGC /* no argument count passing */
2 /*
3 ** reverse string in place
4 */
5 reverse(s) char *s; {
```

(Continued on page 66)

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Small-C Library (Listing Continued)

Listing Two

```
6 char *j;
7 int c;
8 j = s + strlen(s) - 1;
9 while(s < j) {
10     c = *s;
11     *s++ = *j;
12     *j-- = c;
13 }
14 }
15
```

File: REWIND.C

```
1 #define NOCCARGC /* no argument count passing */
2 /*
3 ** Rewind file to beginning.
4 */
5 rewind(fd) int fd; {
6     return(cseek(fd, 0, 0));
7 }
```

File: SIGN.C

```
1 /*
2 ** sign -- return -1, 0, +1 depending on the sign of nbr
3 */
4 sign(nbr) int nbr; {
5     if(nbr>0) return 1;
6     if(nbr==0) return 0;
7     return -1;
8 }
```

File: STRCAT.C

```
1 /*
2 ** concatenate t to end of s
3 ** s must be large enough
4 */
5 strcat(s, t) char *s, *t; {
6     char *d;
7     d = s;
8     --s;
9     while (*++s);
10    while (*s++ = *t++);
11    return(d);
12 }
```

File: STRCHR.C

```
1 /*
2 ** return pointer to 1st occurrence of c in str, else 0
3 */
4 strchr(str, c) char *str, c; {
5     while(*str) {
6         if(*str == c) return (str);
7     }
```

```
7     ++str;
8 }
9 return (0);
10 }
```

File: STRCMP.C

```
1 /*
2 ** return <0, 0, >0 according to
3 ** s<t, s=t, s>t
4 */
5 strcmp(s, t) char *s, *t; {
6     while(*s == *t) {
7         if(*s == 0) return (0);
8         ++s; ++t;
9     }
10    return (*s - *t);
11 }
12
```

File: STRLEN.C

```
1 /*
2 ** return length of s
3 */
4 strlen(s) char *s; {
5     char *t;
6     t = s - 1;
7     while (*++t);
8     return (t - s);
9 }
```

File: STRCPY.C

```
1 /*
2 ** copy t to s
3 */
4 strcpy(s, t) char *s, *t; {
5     char *d;
6     d = s;
7     while (*s++ = *t++);
8     return(d);
9 }
```

File: STRNCAT.C

```
1 /*
2 ** concatenate n bytes max from t to end of s
3 ** s must be large enough
4 */
5 strncat(s, t, n) char *s, *t; int n; {
6     char *d;
7     d = s;
```

(Continued on page 68)

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 FLAGS : ARRAY [0..SIZE] OF BOOLEAN;

```
BEGIN
  WRITELN( 'START' );
  FOR ITEM := 1 TO 10 DO BEGIN
    COUNT := 0;
    FOR I := 0 TO SIZE DO FLAGS[ I ] := TRUE;
    FOR I := 0 TO SIZE DO
      IF FLAGS[ I ] THEN BEGIN
        PRIME := I + 1 + 3;
        K := I + PRIME;
        WHILE K <= SIZE DO BEGIN
          FLAGS[ K ] := FALSE;
          K := K + PRIME;
        END;
        COUNT := COUNT + 1;
      END;
  END;
  WRITELN( COUNT, 'PRIMES' );
END.
```

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Small-C Library (Listing Continued)

Listing Two

```
8  --s;
9  while(++s);
10 while(n--) {
11     if(*s++ == *t++) continue;
12     return(d);
13 }
14 *s = 0;
15 return(d);
16 }
```

File: STRNCMP.C

```
1 /*
2 ** strcmp(s,t,n) - Compares two strings for at most n
3 **                  characters and returns an integer
4 **                  >0, =0, or <0 as s is >t, =t, or <t.
5 */
6 strcmp(s, t, n) char *s, *t; int n; {
7     while(n && *s==*t) {
8         if (*s == 0) return (0);
9         ++s; ++t; --n;
10    }
11    if(n) return (*s - *t);
12    return (0);
13 }
```

File: STRNCPY.C

```
1 /*
2 ** copy n characters from sour to dest (null padding)
3 */
4 strncpy(dest, sour, n) char *dest, *sour; int n; {
5     char *d;
6     d = dest;
7     while(n-- > 0) {
8         if(*d++ == *sour++) continue;
9         while(n-- > 0) *d++ = 0;
10    }
11    *d = 0;
12    return (dest);
13 }
```

File: STRRCHR.C

```
1 /*
2 ** strrchr(s,c) - Search s for rightmost occurrence of c.
3 ** s          = Pointer to string to be searched.
4 ** c          = Character to search for.
5 ** Returns pointer to rightmost c or NULL.
6 */
7 strrchr(s, c) char *s, c; {
8     char *ptr;
9     ptr = 0;
10    while(*s) {
```

```
11        if(*s==c) ptr = s;
12        ++s;
13    }
14    return (ptr);
15 }
```

File: TOASCII.C

```
1 /*
2 ** return ASCII equivalent of c
3 */
4 toascii(c) int c; {
5     return (c);
6 }
```

File: TOLOWER.C

```
1 /*
2 ** return lower-case of c if upper-case, else c
3 */
4 tolower(c) int c; {
5     if(c<='Z' && c>='A') return (c+32);
6     return (c);
7 }
```

File: Toupper.C

```
1 /*
2 ** return upper-case of c if it is lower-case, else c
3 */
4 toupper(c) int c; {
5     if(c<='z' && c>='a') return (c-32);
6     return (c);
7 }
```

File: UNGETC.C

```
1 #define NOCCARBC /* no argument count passing */
2 #include stdio.h
3 extern _nextc[];
4 /*
5 ** Put c back into file fd.
6 ** Entry: c = character to put back
7 **        fd = file descriptor
8 ** Returns c if successful, else EOF.
9 */
10 ungetc(c, fd) int c, fd; {
```

```

11 if(!_mode(fd) || _nextc[fd]!=EOF || c==EOF) return (EOF);
12 return (_nextc[fd] = c);
13 }

```

File: UNLINK.C

```

1 #define NOCCARGC /* no arg count passing */
2 #include stdio.h
3 #include clib.def
4 /*
5 ** Unlink (delete) the named file.
6 ** Entry: fn = Null-terminated CP/M file name.
7 **          May be prefixed by letter of drive.
8 ** Returns NULL on success, else ERR.
9 */
10 unlink(fn) char *fn; {
11     char fcb[FCBSIZE];
12     pad(fcb, NULL, FCBSIZE);
13     if(_newfcb(fn, fcb) && _bdos(DELFIL, fcb) != 255)
14         return (NULL);
15     return (ERR);
16 }
17 #asm
18 delete equ    unlink
19     entry delete
20 #endasm

```

File: UTOI.C

```

1 #include stdio.h
2 /*
3 ** utoi -- convert unsigned decimal string to integer nbr

```

```

4 **          returns field size, else ERR on error
5 */
6 utoi(decstr, nbr) char *decstr; int *nbr; {
7     int d,t; d=0;
8     *nbr=0;
9     while((*decstr>='0')&(*decstr<='9')) {
10         t=*nbr;t=(10*t) + (*decstr++ - '0');
11         if ((t>=0)&(*nbr<0)) return ERR;
12         d++; *nbr=t;
13     }
14     return d;
15 }

```

File: XTOI.C

```

1 #include stdio.h
2 /*
3 ** xtoi -- convert hex string to integer nbr
4 **          returns field size, else ERR on error
5 */
6 xtoi(hexstr, nbr) char *hexstr; int *nbr; {
7     int d,t; d=0;
8     *nbr=0;
9     while(1)
10     {
11         if((*hexstr>='0')&(*hexstr<='9')) t=48;
12         else if((*hexstr>='A')&(*hexstr<='F')) t=55;
13         else if((*hexstr>='a')&(*hexstr<='f')) t=87;
14         else break;
15         if(d<4) ++d; else return ERR;
16         *nbr=*nbr<<4;
17         *nbr=*nbr+(*hexstr++)-t;
18     }
19     return d;
20 }

```

End Listings

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Comments on "Sixth Generation Computers"

The dialogue between Michael Doherty and Richard Grigonis stretches back over the past year and a half. Having begun things in December 1982 with a brief discussion of fifth generation computers, Grigonis held forth last month on what to expect in the sixth generation. Here are Doherty's thoughts in reply. — Ed.

Most readers may recall my previous confrontations with Richard Grigonis in the pages of *Dr. Dobb's Journal* and how ridiculous he made me look with his article "And Still More Fifth Generation Computers" in August 1983. Naturally, it was with a feeling of great foreboding that I recently opened an envelope bearing the corporate logo of the Children's Television Workshop, as it could mean only one thing: Grigonis was sending me an advance copy of his latest article ("Sixth Generation Computers") and was daring me to do something about it!

Upon reading the article, however, I was relieved to discover that Grigonis's vast intellect had finally confounded itself and that I may yet emerge victorious from a final confrontation. Grigonis doesn't make it any easier on himself when he writes that the favorable response to his last article has encouraged him to write yet another opus, "taking speculation about future computers to the limits that can be conceived of by the human mind." His modest claims remind me of the tale of Erasmus from those strange post-Biblical writings known as the Apocrypha. The story goes that Erasmus, most learned man on Earth, wishes to demonstrate that, like Jesus, he can ascend even unto heaven, and so he begins to float up into the sky. Saint Peter, appalled at this flagrant display, prays to God that something be done, whereupon Erasmus falls to Earth and breaks his arms and legs. Saint Peter then breathes a sigh of relief and sternly notes to the reader that "here was a man who could fly like a bird, and now he cannot even crawl like a worm."

by Michael Doherty

Grigonis's predictions this time around include reducing the execution time of artificial intelligence (AI) programs by building processors having signals that can travel faster than light, which incidentally allows the computer to answer questions even before the programs asking the questions are run! His other prediction is that we will be able to communicate with such "superluminal" sixth generation computers through a technique whereby the computer reads the user's mind! These ideas definitely beg closer scrutiny, so let us continue.

First of all, most physicists at one time would have agreed with Grigonis's statement that "there is nothing in relativity theory, quantum mechanics, electrodynamics, or mechanics that says that time must move in one direction," but a little item from quantum mechanics may one day prove otherwise: namely, the controversy over the conservation of charge conjugation, parity reflection, and time reversal, the so-called "CPT theorems" initially stated by Wolfgang Pauli in 1942 and proved by the Swiss physicist Res Jost in 1958. The strong possibility exists that certain subatomic processes can move only forward in time. On the other hand, violations of the conservation laws may be possible, and we therefore might have to throw out most of physics, but this is unlikely. The whole question is still up in the air and is certainly not as open-and-shut as Grigonis states.

Physicist Bryce S. DeWitt, however, writing in a recent issue of *Scientific American*, discusses the idea of "quantum gravity" and how a subatomic event that is quick enough, or of a high enough energy, could reveal the quantum "grainy" structure of space-time, thereby blurring the distinction between the past and future.¹ In more scientific terms, if gravitation (and, hence, space-time) is quantum in nature, then the shape of the light cone defining the regions of space-time that are accessible from a given point in space and moment in time would act as if it were "fuzzy." Therefore, the ordinary accepted phenomenon of two points in space-time communicating with each other by means of signals moving equal to or less than the speed of light can be given only a probabilistic certainty. At tiny Planckian dimensions (1.61×10^{-33} centimeter), at Planckian time units (5.36×10^{-44} second), and at high enough energies, the probability of a signal traveling faster than the speed of light between two points

could be very high indeed or at least high enough to make one of Grigonis's superluminal processors possible.

But to test Grigonis's theory, the energies required to explore this subatomic realm would be immense. As DeWitt writes in his article: "To probe these scales of distance and time experimentally, using instruments built with present technology, one would need a particle accelerator the size of the galaxy!" I somehow doubt that even IBM would want to build one of Grigonis's proposed sixth generation computers if it entailed having to construct superluminal processor switches the size of the Milky Way!

Grigonis tries to get around this with all sorts of ingenious arguments that hover at the most distant horizon of theoretical physics. I would like to comment on them but I don't feel that I'm qualified. Indeed, I can think of only a handful of physicists in the world who are capable of seriously evaluating some of the things he suggests, which makes me wonder how he thought of them himself!

As for the "mind-reading" aspects of his proposed computer, I also find these difficult to disprove, but only because the physics is once again beyond my level of training. In fact, I have a sneaking suspicion that Grigonis may even be right! Richard Feynman and Steven Weinberg, where are you when we need you?

Moreover, Grigonis has reduced all of AI to a matter of searching through a search space that consists of the logical relationships of every known fact or assertion. Instead of resorting to forms of constrained, heuristic search, Grigonis astonishes us with his suggestion to stay with the "brute force" method and simply build computers with processors having signals moving faster than the speed of light.

Grigonis warns us that such superluminal computers would answer our questions long before we ever ask them. He proposes to solve this problem by placing every query in a buffer where a conventional computer and AI program "would analyze the parameters of the question and estimate the appropriate amount of time to wait before sending the question to the superluminal processor." Grigonis goes on to assure us that, "if the statement was accurate, the delay period of submitting the question to the superluminal processor would be just a little longer than the negative time required for an answer . . ." The answer

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thus would appear immediately after you enter the question instead of sometime in the past.

The problem with making a "rough estimate" of the execution time of any program is that, because of such things as Gödel's Proof and Turing's Halting Problem, such an estimate can only be rough, never precise: there is no way to determine whether a Turing machine (digital computer) is ever going to stop running any particular program. As Gödel discovered, there are "undecidable propositions" in logic; certain problems take an infinite amount of time to solve because they are unsolvable, and no logical way exists to determine if the computer is ever going to stop. All of this means that, if one of Grigonis's sixth generation computers were studying a really difficult, "interesting" problem, then the estimate of how long to hold the query in the buffer would certainly be off by at least an order of magnitude, and the answer could appear unpredictably in the past, present, or future!

Grigonis ignores another plan that does not require a superluminal processor, but here too the argument breaks down. I am referring to the constant trade-off of processing time versus storage size. Instead of using simple assertions and a resolution problem solver, one could make the knowledge representation of a particular problem more powerful by storing large, complex frames or semantic nets on disk.

For example, Grigonis is correct when he says that, given an initial chess position, up to 10^{150} move sequences are possible, requiring eons of processing time to search through. However, let's imagine that we've already calculated every possible move in every possible chess game *once* and have stored them all on a gigantic disk drive in the form of a series of records or vectors. With such an extreme form of knowledge representation, the processing time becomes almost zero as the problem of making the next move is now reduced to looking up entries in a table; the program simply looks up the current configuration of chess pieces on its internalized "chart" and immediately sees the entry that tells it the best move to make next. Deduction as such would be unnecessary, since this or any other problem situation could in theory be made complete in terms of all relevant objects, properties, and relations.

Of course, we have traded one impossibility for another: instead of an infinite amount of processing time, we now must provide an infinite number of disk drives! Besides, one rarely has a complete description of any problem situation, and a representation formalism based on logic does make it possible to express generalizations economically in spite of this. Still, just because we can deduce the behavior (the

various possible states) of a system from its description as a set of subsystems or even simple assertions does not imply that the system can be *explained* from any kind of modular, logical, representation/resolution, theorem-proving process. AI researchers had hoped to develop logical, problem-independent solution methods, but we now know from metamathematical grounds that no general, efficient, problem-independent solution technique exists.^{2,3}

And what if the fundamental concepts themselves cannot be broken down into their component features with any utility? E. Rosch,^{4,5} K. Nelson,⁶ and

D. S. Palermo,⁷ just to name a few, have complained that the feature theory of semantic development in human language is wrong, that things are more complicated than just applying good old reductionism to the problem of meaning.

In feature theory, features are abstracted from a whole concept so that the concept's meaning can be known. But one must already know that whole concept in order to know what features to abstract from it. Also, as Nelson says, like Humpty Dumpty there is no way of putting the abstracted features together to form the original whole. As Palermo points out, "a list of features is not a concept."

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Names or words referring to categories are acquired as a whole and not feature by feature. They are highly structured internally but paradoxically do not have sharp, distinct boundaries; therefore, things are classified not by their features but by their "distance" from an ideal prototype or "core exemplar," which sounds suspiciously like Plato's old philosophy of ideals and his doctrines of *form* and *anamnesis*. Rosch shows that categories are universal across languages because they are intrinsic biological structures given genetically to the brain from its evolutionary heritage.

All of this would explain why, like the conceptual dependency theory of semantic primitives in AI programs, the feature theory of human semantic acquisition ignores the existence of metaphors, even though it is almost impossible in practice to differentiate between metaphors and nonmetaphors. We can speak nonmetaphorically of "the long arm of the man," but we can also easily comprehend "the long arm of the crane," or "the long arm of the law." All words have some metaphoric power, the ability to overlay two different objects or events. As Marvin Minsky has written: "What something means to me depends on everything else I

know . . . every meaning is built on other meanings, with no special place to start."⁸

Similarly, it also seems impossible to assign items to a finite number of categories and then state rules in terms of membership in those categories. John Ross, for instance, observed that certain verb structures could generally be used in place of a noun phrase with varying degrees of acceptability.⁹ For example, the gerund "his going" can be used in the same positions as a normal noun phrase:

I regretted *his going*.

His going surprised me.

After *his going* we hired a new worker.

His going's main effect was to end the feud.

Ross thought that properties like "noun-ness" could be placed along a scale he called a *squish*. His attempts to devise a rigorous formalism for squishes have not met with success, and AI researchers in the natural language processing field tend to sweep them under the rug.

So it seems that a computer program can have only a syntax — no real semantics. Of course these squishes, like the other feature/category problems, could be explained if the human brain were viewed not as a discrete machine like a Turing machine or a digital computer but as a

series of parallel analog devices.

This brings us to some fundamental problems that Grigonis ignores. Since a universal Turing machine can simulate any calculating device or physical expression of any algorithm, and assuming that the mind arises out of the physical workings of the brain, it follows that the physical embodiment of a Turing machine (the digital computer) can simulate human cognition.

But what if the human brain is not a Turing machine? What if it is some kind of nondiscrete analog device? This would explain how it can comprehend continuous spectra of physical state changes without analyzing each discrete state. Or worse yet, what if the brain is a series of parallel analog processors?

John Searle exposed an even more fundamental misconception among AI researchers when he demonstrated that cognition is not solely a matter of formal symbol manipulation.¹⁰ Most AI researchers think that "the mind is to the brain as the program is to the hardware," which implies that a Turing machine in the form of a program running on a digital computer can achieve cognition. This ignores the fact that, while even primitive AI programs can do things that people can do, they utilize only simple computations that have nothing to do with the kind of actual cognitive states experienced by humans.

After all, the strange fact about AI has always been that it's easier to simulate an expert than to simulate the general common sense of a five-year-old. Daniel Bobrow's STUDENT program could solve high school algebra word problems, and James Slagle's SAINT and Joel Moses's SIN programs could solve rather complex, abstract calculus problems. Amazingly, these programs relied on only about a hundred rule-based "facts" to achieve their mathematical miracles, whereas Terry Winograd's SHRDLU program, designed to manipulate a simple world of children's building blocks, was over 80,000 words long and required many more rules than most of the "expert" systems!

As Searle says, "simulation is not duplication." A person with a photographic memory, after all, could memorize a program and "think it through," immediately realizing that no intentional states are involved, just a set of instructions having nothing to do with "understanding." As Searle writes: "No one supposes that computer simulations of a five-alarm fire will burn the neighborhood down or that a computer simulation of a rainstorm will leave us all drenched. Why on earth would anyone suppose that a computer simulation of understanding actually understood anything?" AI researchers are still under the spell of the Turing Imitation Game, with its strong smell of behaviorism and operationalism.

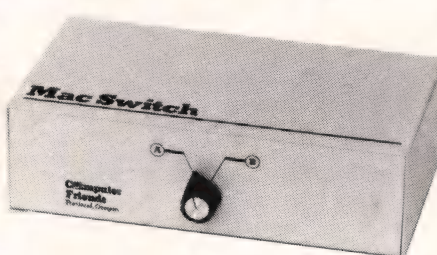
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Ironically, the idea that cognition can be expressed in a set of logical transformations — a computer program — set apart from the hardware, be it computer or brain, implies a strange mind/body dualism that goes against the avowed materialistic stance of AI researchers. Suppose the biochemical reactions of the brain itself are responsible for cognition? As Hubert L. Dreyfus has pointed out, knowledge representation with formal symbols and transformations may be unnecessary in human cognition: "... these are usually nonformal representations, more like images, by means of which I explore what I *am*, not what I *know*. We thus appeal to *concrete* representations (images or memories) based on our own experience without having to make explicit the strict rules and their spelled out *ceteris paribus* conditions required by *abstract* symbolic representations."¹¹

So although humans are sometimes annoyingly imperfect thinkers, at least they do think, unlike AI programs and the computers that run them. The fundamental workings of the universe since the Big Bang seem to legislate against building one of Grigonis's "ultraintelligent machines."

In closing, let me thank *Dr. Dobb's Journal* for allowing me to once again

continue the "Grigonis-Doherty debate" within its pages. I can think of no other publication in this country with a readership capable of appreciating such esoterica. And, despite appearances to the contrary, I would also like to thank the Grand Master of Computerdom himself, Richard Grigonis, for writing the most brilliant and daring series of articles of the past 30 years, or at least since the legendary days of Alan Turing and Johnny von Neumann.

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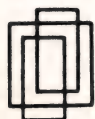
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How many times have you said to yourself, "What this industry (still) needs is a good, low-cost Pascal compiler"? We've said the same thing ourselves, and we were fascinated to learn about Turbo Pascal. Not only low in price, it was advertised to be fast, take very little space, and include a resident editor. In addition, from everything we can determine, Borland ships promptly and provides good support. They have even disposed of their \$100 commercial licensing fee.

Sound too good to be true? Well, the following review suggests that Turbo Pascal is what it claims. By the time you read this (lags in publishing being what they are) you will probably have seen ads in DDJ for a version 2.0 that provides even more features, including automatic overlays, windows (at least for IBM PC and PC Jr.), and a dispose function. We will provide an update on that newer version in the next few months. In the meantime, Borland deserves watching. With similar packages for Modula-2 and C coming soon, their potential impact should not be underestimated. — Ed.

Turbo Pascal, V.1.01

Company: Borland International, 4807
Scotts Valley Drive, Scotts Valley,
CA 95066

Computer: CP/M-80, MS-DOS, or
CP/M-86

Price: \$49.95

Circle Reader Service No. 119

Reviewed by David D. Clark

The advertisements say that "This is the Pascal compiler everybody's been waiting for." They may be right. Turbo Pascal, from Borland International, is an excellent product at an extraordinary price. Some people may be leery of a low-priced Pascal compiler after having had a bad experience with JRT Pascal. I myself had similar feelings when I saw the advertisements for Turbo Pascal. Since using the product, though, I have been pleasantly surprised. *Amazed* might be a better word.

When you open the package, you find a disk and a reference manual. The disk contains several programs and text files. TURBO.COM (or TURBO.COMD), TURBOMSG.OVER, and TURBO.OVR make up the compiler/editor, error messages, and a temporary program loader. Also present are an installation program and associated data file, a program-

listing utility, an errata file, and the source files for a simple spreadsheet program called MicroCalc.

Turbo Pascal has many interesting and innovative features. It is very small, only about 28K. A full-screen editor is co-resident with the compiler. The compiler is exceptionally fast. Versions are available for both 8-bit and 16-bit systems. The user can develop highly standard, portable programs. The programs are reasonably fast. A floating-point format with eleven decimal digits allows business applications to handle dollars and cents calculations to \$999,999,999.99. Access is provided to the underlying hardware and operating system facilities. In-line machine language can be generated, and the user can control compiler operation with a variety of directives.

The Editor

The built-in, full-screen editor is one of the major conveniences this package provides. It is co-resident with the compiler and, as such, allows a speed of interaction during program development that is unprecedented with a compiled language. It is possible to enter the editor part of the package, create the source text for a program, exit from the editor, compile the text in memory, and immediately return to the editor in the event of a compilation error, all without any disk access required. It's fast.

The first thing you will want to do after scanning the reference manual is install the editor for your computer. This is done by running the installation program TINST. There are two parts to the process: terminal installation and command installation. The first and most important is installing the correct terminal driver for your CRT. TINST uses a data file containing information about a number of common terminals. If yours is one of those already known to the system, you will just have to select it from a menu and the program will finish the installation. If your terminal is not one of those listed, or if you wish to change the default parameters for a listed terminal, you will be led through a series of questions that will set up the system to run with your equipment. I tried the installation procedure with three different terminals. The system had menu entries for two of them, a Zenith and a TeleVideo, and installed them without a hitch. I also installed the system on a North Star Advantage, which is not listed

in the menu. The installation process was clear and quick — you just need to know the control codes for your particular terminal.

Turbo Pascal has several procedures that are extensions to standard Pascal and that allow control of the video screen of your terminal. You must complete the installation process correctly in order to guarantee that these procedures work as expected.

The default commands for the editor are a subset of those used by WordStar. Cursor movement, insertion, deletion, find, replace, and the block commands are almost identical with those of WordStar. Some additional commands are also present. The editor's differences from WordStar, such as its incorporation of automatic indentation and a single command to mark a word as a block, make the editor easier to use in a program-development environment than WordStar. If you know WordStar, you will be able to use the Turbo editor.

The installation program also allows you to change the characters used to invoke each command. If you don't like the default choices, it's easy to alter them. Just remember to write down your changes somewhere.

Running Turbo Pascal

The heart of the system consists of the program TURBO. While running, TURBO is a simple program-development environment. When you first start TURBO, it informs you of the terminal it has been installed for and asks if you wish to include error messages. If you respond with an affirmative, a text file containing the compiler error messages will be loaded. These contain the text that will be displayed in the event the compiler detects an error while translating a program. If you do not load the error messages, you will have about 1.5K additional free memory, but the compiler will just print out a number when it detects an error. After the error messages are loaded (or not), a menu is displayed on the screen. The available options are shown in Table 1 (page 75).

Speed

A rather large demonstration program is included as a group of source files on the distribution disk. It is a simple spreadsheet program called MicroCalc. The first thing I did after backing up the master disk (even before installing

the editor) was compile this program. That was when I got my first surprise. The 1261-line program was compiled to a 22K object file in almost exactly one minute. This is just about the fastest compilation speed I have ever seen on an 8-bit microcomputer.

When compilations are done in memory (selected with the Options menu), the process is even faster because there are no disk-write accesses to slow things down. It is a truly impressive thing to see. I ran a couple of benchmarks to see how fast the generated code is. The first was the (in)famous *Byte* sieve prime-number generator. The program compiled almost instantly in memory, too fast for me to get an accurate measurement by hand. It generated 301 bytes of code (not including the data space occupied by the large Boolean array). The program executed in 24 seconds. Although this is not the fastest execution speed, it isn't too shabby either. It is much faster than UCSD or JRT Pascal and several seconds faster than the C version of the program when compiled with Aztec C II or Eco-C on my system.

Another benchmark I tried was the floating-point program from *Dr. Dobb's* No. 83 and No. 89. Because Turbo Pascal does not include a standard function for calculating the arctangent, the program declared a function to calculate one. This program took 337 seconds to execute (again compilation was almost instantaneous) and had an error of 4.6E-3 from an exact answer of 2500. This is not too bad for software floating point on an 8-bit machine, especially when you consider that the floating-point format in Turbo Pascal uses a 40-bit mantissa (about 11 significant decimal digits), compared to 24 bits (about 7 significant decimal digits) in normal single-precision.

The Reference Manual

The reference manual is a paper-bound book of about 260 pages. The main part of the manual describes the features common to both the 8-bit and 16-bit versions of Turbo Pascal. The first two appendices, each about 30 pages, describe those parts of the system, specific to either the 8- or 16-bit version. The appendix describing the 16-bit version is further divided into sections covering the MS-DOS version and the CP/M-86 version. There are also a number of additional appendices that list the standard procedures and functions, operators, compiler directives (described below), differences from standard Pascal (also described below), compiler error messages, runtime error messages, I/O error messages, translation of error messages to foreign languages, detailed installation procedures, Turbo Pascal syn-

tax, the ASCII character set, and a subject index.

Although the manual states that it is not intended to teach Pascal, it does cover the language features thoroughly with lots of examples. Unfortunately, there are some rough spots. There is a tendency to use *e.g.* with annoying frequency and often at an inappropriate place in a sentence. The same thing occasionally happens with *i.e.* A word processor appears to have been allowed free rein with decisions on where to hyphenate words. For example, "sc-reen" and "th-rough" are two of the more blatant blunders.

These errors aren't really too important. Every book of this size has some typographical or usage errors. Even reviews such as this one are not immune. Real confusion can occur when a program example is in error or does not agree with the surrounding text. For

example, in the discussion of operations on text files, an example program declares a variable of type Text named "F." In the body of the program, however, all text-file operations are performed on an undeclared variable "FilVar."

If there is a weak point in the system, it is the reference manual. It isn't too bad, but it isn't anything great either. Mostly it's just sloppy. It needs one more thorough edit.

Deviations from Standard Pascal

The degree to which a particular implementation of a programming language adheres to the language standard affects the portability of programs developed with that implementation. Turbo Pascal uses the *Pascal User Manual and Report* by Kathleen Jensen and Niklaus Wirth, *not* the ISO standard, as the definition of standard Pascal. For most users,

Logged drive	Allows you to change the currently logged drive.
Work file	The work file is the file maintained in memory for alterations with the editor.
Main file	This command is used when the work file contains a file that is included from some other main program. If you later elect to compile a program, the work file will be saved and the main file will be read into memory for compilation.
Edit	Takes you to the editor to create or alter the work file.
Compile	Compile the work file or main file if different from the work file. A successful compilation can result in a "COM" (or "CMD") file, a "CHN" file, or a memory resident program, depending upon the selections made with the Options menu item.
Run	This command will run a memory resident or executable file. If the program has not been compiled, the compiler will be invoked automatically.
Save	Used to save an altered work file back to disk. Any previous version is renamed with the file extension "BAK" before the new version is saved.
Execute	Will run another program from TURBO. When the program terminates, control is transferred back to the TURBO program.
Directory	Allows viewing the contents of a disk directory. Disk specifiers and wild cards are allowed.
Quit	Exits the TURBO program. If the work file has been altered but not saved, you will be asked if you want to store it before leaving the program.
Options	This command varies slightly in the 8-bit and 16-bit versions. It allows you to direct the compiler to construct a program in memory or to disk. If a disk file is selected, it can be one of two types: an executable "COM" (or "CMD") file or a "CHN" file. A "CHN" file can be "chained" to or from another Turbo Pascal program. It does not contain the runtime library because one will be present from the calling program. Because no library is present, "CHN" files are about 8K smaller than executable files. It is also possible to specify the starting address of a program and the last memory location available to the program with the 8-bit version. The 16-bit version allows the user to specify a minimum code-segment size, a minimum data-segment size, and the minimum and maximum allowable dynamic memory.
	The options command also allows you to find where a runtime error occurred in a "COM" or "CHN" file.

Table 1

the difference between the two standards will be small, the largest difference being the inclusion of conformant arrays in the ISO standard. I'm not aware of a micro-computer-based Pascal that implements conformant arrays yet, anyway.

One of the appendices of the Turbo reference manual discusses deviations from the Jensen and Wirth standard. These fall into (basically) six areas and are mostly concessions to efficiency; that is, abandoning facilities that are difficult to implement. The deviations discussed do not include the many extensions available in the Turbo version. The deviations are:

1. The standard procedure **Dispose** is not available. Instead, you can manage heap space (used for dynamic variable allocation) by use of the

standard procedures **Mark** and **Release**. The dynamic-variable allocation procedure **New** is also restricted; the Turbo version does not allow variant record specifications.

2. The standard I/O (input/output) procedures **Get** and **Put** are not implemented. Instead, the **Read**, **ReadIn**, **Write**, and **WriteIn** have been extended to handle all I/O.
3. The **Goto** statement is restricted in that it may transfer control only within the current block.
4. The standard procedure **Page** is not implemented.
5. Variable packing and unpacking are not under user control. Variables are packed whenever possible. Because of this, the reserved word **packed** has no effect and the standard proce-

dures **Pack** and **Unpack** are not implemented.

6. A program may not pass procedures and functions as parameters to other subroutines.

The discussion of the **with** statement in the main body of the reference manual would also lead you to believe it is nonstandard. According to the manual, the user must dereference successive fields within records with commas instead of with periods as in standard Pascal. The number of records that the user can open using a **with** statement is also restricted, but the user can change that number by use of the "W" compiler directive. The version of the compiler I used was capable of handling the standard syntax as well. In fact, on all the tests I ran, using the standard form generated slightly less code than the technique presented in the reference manual.

Finally, the error messages are not the same as in the *Pascal User Manual and Report*. This is not really a standard, but most compilers based on the P4 portable compiler, developed by Professor Wirth's colleagues in Zurich, do use the same set of error messages.

I transferred several programs written for the UCSD version of Pascal to CP/M for use with Turbo Pascal. In most cases, the revisions needed to get the programs running under Turbo Pascal were minor, usually involving things that the UCSD system implements in a nonstandard manner, like opening files. I did have some difficulty in converting programs that made extensive use of the **Get**, **Put**, and **Dispose** standard procedures.

Extensions

Turbo Pascal provides a large number of extensions to standard Pascal. They usually support a simple means of doing something that is clumsy or impossible within the constraints of the standard language—for example, one provides direct access to the underlying hardware. These extensions may be convenient, but programs developed with them will be less portable than those that use only the facilities available in the standard.

The extensions available are numerous, so I will briefly summarize some of them. To paraphrase from the user's manual, they include:

1. Dynamic strings. Strings are almost indispensable for many programs. Most implementations of Pascal on microcomputers provide strings of some sort, so they are almost a standard. Turbo Pascal strings, and standard procedures and functions to manipulate them, closely resemble those available in other implementations such as JRT Pascal and UCSD Pascal.

The directives common to both versions are:

- B** Controls which physical devices are attached to the standard files **Input** and **Output**. When active (the default condition), the CON: device is used. When inactive, **Input** and **Output** are attached to the TRM: device. The CON: device provides buffered input with limited editing capabilities, while the TRM: device does not. This directive affects the entire program and may not be switched on and off within the program.
- C** When active, as it is by default, this option allows the user to interrupt program execution by typing a Control-C in response to a **Read** or **ReadIn** statement. You can use Control-S to halt console output temporarily.
- I** This directive has two functions. When followed by a file name, the contents of the file named will replace the comment in the compilation. The other use turns I/O error handling on (the default) or off. If an I/O error occurs while error checking is active, the program will be terminated. If checking is off, the user program is responsible for error detection by use of the standard function **IOError**.
- R** This directive determines whether runtime index-checking of arrays and strings is performed. Checks are turned off by default. Until a program is thoroughly debugged, checking should be turned on; otherwise, an index error can cause a program to crash—or worse, could cause undetected damage to data.
- V** This directive, which is normally on, determines how rigorous type-checking is when strings are passed as parameters. While active, strings passed as variable parameters must have been declared with the same maximum dynamic length as the formal parameter type. When inactive, the compiler will allow you to pass an actual parameter with a maximum length different from the formal parameter of a subroutine.
- U** If this directive is active, the user can interrupt the compiled program at any time by typing a Control-C. If inactive, as it is by default, Control-C will have no effect. Activating this option significantly decreases speed and slightly increases code size.
- X** This directive controls speed versus size optimization during calculation of array indices. When active (the default), optimizations are made for speed at the expense of code size. With the programs I tested, this option had an effect only when arrays with two or more dimensions were present.

The directives unique to the 8-bit implementation are:

- A** When active (the default state), the compiler will generate code for nonrecursive subroutines. When switched off, the code generated will allow recursive calls with a penalty in code size.
- W** The allowed nesting of **with** statements is controlled by the setting of this variable. It initially allows a nesting of two levels. As mentioned earlier, this directive has an effect only when you use the nonstandard method of opening nested records described in the manual. This directive has no effect if you use standard syntax in **with** statements.

Table 2.

2. Variable declarations specifying an absolute address to be occupied by the variable.
3. Bit and byte manipulation.
4. Direct access to memory, data ports, and operating-system facilities.
5. Relaxed restrictions on the ordering of **const**, **type**, and **var** declarations.
6. Ability to generate in-line machine code.
7. File inclusion from the main program.
8. Logical operations on integers, such as left and right shifts.
9. Program chaining with common variables.
10. Random-access data files.
11. Structured constants that allow a form of initialized variable declaration.
12. Type-conversion functions.
13. A large number of built-in routines to allow control of video terminals.

Extensions have also been made to the syntax of some statements. For example, the **case** statement allows an optional **else** part and subranges in case labels.

Compiler Directives

The user can control the operation of the compiler by use of several compiler directives included in programs as a special form of comment. There is a group of directives common to both the 8-bit and 16-bit versions of the system, as well as some present only on the 8-bit or 16-bit versions. These are shown in Table 2 (page 76).

There is only one directive specific to the 16-bit versions of Turbo Pascal. When the "K" directive is active, as it is initially, a check is made for adequate stack space before each subroutine call. When the directive is turned off, no such checks are performed.

Chaining and External Procedures

There are no true separate compilation facilities available with Turbo Pascal. Because compilation is so fast, however, it is almost as easy to develop files of commonly used routines and include them in the compilation of the main program as it would be with a separate-compilation feature. Except for very large packages of routines, this should be sufficient for most needs.

Also, there are no program-overlay or -segment facilities. It is possible to compile a program of type "CHN" that can be called from another Turbo Pascal program with the **Chain** standard procedure. A "CHN" file does not contain a copy of the Turbo Pascal runtime package and is, therefore, smaller than a "COM" file would be. In addition, it is possible to share variables between the calling program and the program chained

to. You can use the **Execute** procedure to start execution of a "COM" file from a Turbo Pascal program. Both of these procedures place a value of FF (hex) in the command-line buffer as a means of notifying the called program that it has been invoked from another program. Because of this, calls should not be made to programs that expect to make use of information from the command line.

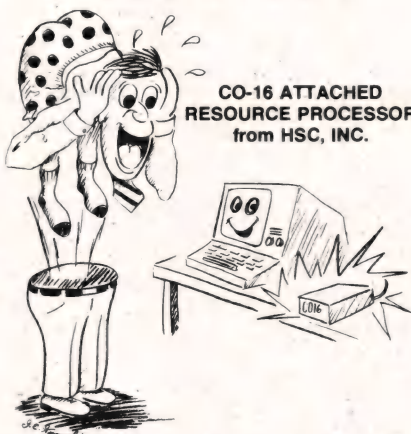
The use of external procedures is a little tricky in Turbo Pascal. It doesn't appear to be possible at all with programs compiled in memory. With a minor deviation, external procedures and functions are declared in a manner similar to the

declaration of a **forward** subroutine; the procedure or function heading is specified, followed by the **external** reserved word. Following the **external** reserved word, there must be an absolute address for the routine.

Turbo Pascal assumes that all **external** subroutines will be written in assembly language. The reference manual clearly explains the parameter-passing and function-return protocols needed to make such assembly-language routines work with Turbo Pascal.

When the program is compiled, the starting address must be set explicitly from the Options menu to make room

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for the external subroutine between the runtime library and the rest of the program. I could find no way to get such a subroutine into memory at the address specified while the Turbo package was running. Apparently the only way to do so is to compile the program to a "COM" or "CHN" file, then — using the system debugger — overlay the external routine at the appropriate address in the code file and save the altered program. I attempted this with a simple external lowercase-to-uppercase conversion function and it worked. The process is probably a little complicated for a novice programmer.

Conclusions

The system is easy to install. This phase of getting a new program to work often frustrates users, but Turbo Pascal handles the process automatically if you have one of the approximately 30 terminals that it knows about. If you don't, a detailed installation procedure is described in an appendix of the users' manual, allowing installation on any modern CRT terminal. I tried both methods and had no problems.

As initially installed, the command set for the editor is very similar to a sub-

set of WordStar. If you wish, you can change these commands.

Once installation is complete, using the system is a real pleasure. The integration of the compiler with the full-screen editor makes program development a snap. The compiler is incredibly quick, especially when translating a program for immediate execution in memory. The degree of interaction is very nearly that of working with a BASIC interpreter. If a compilation error occurs, the system will take you to the point in the program text where the error was detected. If an error occurs later, while running a program that was compiled in memory, the system will again take you to the source statement that caused the error. If an error is detected while running a "COM" or "CMD" file compiled by Turbo, it is also possible to find the source statement causing the problem.

Another important feature of Turbo Pascal is its size. It is small, both in terms of disk space and memory space. Although I did not try this, it appears that it would be possible to develop and run useful programs on computers with RAM memory as small as 32K.

The compiler accepts almost all standard Pascal statements. It is therefore possible to write highly portable pro-

grams. I had little trouble transferring programs between Turbo Pascal and UCSD Pascal. In many cases, no changes were required to compile and run the programs on either system. When changes were necessary, they were usually simple and straightforward. In most instances, the quality of the code produced was good, comparing favorably in size and speed with other Pascal and C compilers that I use on my system.

Turbo Pascal also has a large number of available extensions. Some allow easy access to low-level hardware and software functions of the host computer. Others include groups of built-in routines that are useful in many programs. Programmers often create libraries containing routines similar to these anyway, such as ones allowing control of the video terminal screen, but the Turbo system has already implemented many such facilities. Programs that use these extensions will probably not be directly portable to non-Turbo environments, but they are convenient.

The system is not without a few shortcomings, however. The absence of **Get**, **Put**, and **Dispose** may prove clumsy for some programs. Turbo Pascal is not acceptable for those applications that absolutely require separate compilation and overlay facilities. The alterations needed to include such capabilities in Turbo Pascal would probably negate many of its more desirable qualities. Also, the MicroCalc program, included as a programming example, requires a little polishing, mostly updating comments to take into account changes made in the program sections they refer to. Finally, the reference manual really needs some more work to bring it up to the quality of the rest of the system.

In short, Turbo Pascal would be an excellent purchase for two groups of computer users: those who already know Pascal and those who don't. Programmers who already use Pascal will find it an exceptional program-development system for the vast majority of applications. Persons who want to learn Pascal should acquire a good textbook as well as the Turbo package. The highly interactive nature of Turbo Pascal will make it nearly painless to "learn by doing" by experimenting with examples in the textbook.

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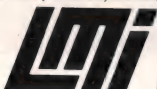
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High-Tech Consulting

By John Zarella

Published by Microcomputer Applications, November 1983

\$18.95 paper, 167 pages

Reviewed by Robert Clark

Consulting is one of the most attractive and potentially lucrative ways for a hardware or software professional to establish an independent enterprise in the field of computer systems. A consulting business can be started on a shoestring, and can be initiated and run effectively by a single person. The business may begin returning profits almost at once, as high-tech companies will pay handsomely for the expertise needed to design new products using the latest technologies.

For those eager to capitalize on the opportunities presented by becoming a consultant, Zarella has some sound if sobering, advice on the business aspects of consulting. There are at least as many pitfalls as there are gold mines in this field, and anyone seriously considering starting out on his or her own will appreciate the pointers offered in *High-Tech Consulting*. Zarella spends little time recounting the attractive aspects of consulting; if you finish this book with as much enthusiasm for becoming a consultant as you had when you started it, your business will probably be extremely successful.

Part one of the book starts by assuming professional technical competence and describing other qualifications necessary for consulting. These include the abilities to listen to clients and analyze their needs, to estimate the time and materials necessary to complete a project, and to produce proposals and provide progress reports and other documentation on the work being done. Verbal communication skills are also needed to convince potential clients that you are the person for the job, and to ensure that they understand your approach to the problem. The latter includes conducting design reviews and explaining your work to technical and non-technical clients.

Zarella goes on to examine several notions about the consulting lifestyle. He admits that there are some advantages to being your own boss, selecting the jobs

on which you will work, setting your rates, and managing your business and personal finances. He is quick to point out, however, that your source of income is always at risk, that your periods of free time will be unpredictable, and that your credit rating will probably disappear.

The second part of the book deals with setting up a consulting business. Such a business may be anything from an after-hours income supplement to a corporation with sizeable office space and many employees. The book is geared toward the one-person enterprise, and briefly covers such things as estimating startup costs, writing a business plan, obtaining a business license, paying taxes, recordkeeping, finding part-time or full-time employees, and dealing with Government red tape. (Think twice before taking a Government contract; filling out forms in triplicate can wipe out profit margins.)

In part three, the day-to-day aspects of running a consulting business are discussed. As a consultant, you will find that substantial energy will go into marketing your abilities, meeting with prospective clients, writing proposals, and other non-billable activities. Setting your rates and bidding on fixed-price jobs must be done with this in mind. These topics are covered along with suggestions on keeping technical records.

Zarella finishes up in part four with the topic of protecting yourself, your family, and your business with contracts, collection schedules, legal advice, patents and copyrights, and insurance, an Appendix of references and selected reading provides additional "how to" sources for the topics covered in this book.

If you follow all of the suggestions in *High-Tech Consulting* for establishing and maintaining your enterprise, you will have a model small business. You will also find yourself swamped in the details of running it. This book is valuable in that it offers advice on virtually every business aspect of consulting, but a one-person business can selectively disregard some of these. For instance, everyone should know what they are committing to when they sign a contract or non-disclosure agreement, but not everyone needs a business plan. Too much paperwork can make one lose sight of the fact that high-tech consulting is the business of hardware and software development, and a successful consultant should be able to enjoy doing just that if sound business practices are followed.

How to Create Your Own Computer Bulletin Board

By Lary L. Myers

Published by Tab Books Inc.

\$12.50 (paper), 214 pages

Reviewed by James Moran*

Although no new ground is covered in *How to Create Your Own Computer Bulletin Board*, Lary Myers has done an admirable job of compiling program code for this book.

Designer of the FORUM80 and TABLOID BBS (Bulletin Board System) in Albany, New York, Myers has written a book that will be particularly useful to computer clubs that are interested in setting up their own boards. The first few chapters of the book serve a dual purpose in that they provide a technical introduction to the programs that follow as well as suggest some preferred BBS designs.

Although a little light on the narrative side, the book covers the basics of bulletin board design and does a good job of pointing out the danger areas in running these boards. In particular, serious BBS designers will appreciate the section on board security and integrity.

The majority of the book is taken up by BASIC and assembler programs that fully document a functional board for Apple and TRS-80 users. With the notable exception of the LTERM intelligent terminal program for TRS users, all of the assembler listings are nicely commented and should prove simple to modify.

The only serious problem with this book is the print quality of some of the listings. Whether this was due to the dot matrix printer that the author used to reproduce the listings or to a quality control problem at the printers is difficult to determine. In any case, for those who are interested, the publisher offers to supply the BBS programs on disk for \$30. In view of the fact that the book is in large part a 160-page compendium of program listings, those BBS enthusiasts who are considering the implementation of their own board might want to bypass the book and just order the program diskette.

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AI's earliest successes were in game playing, but recent work in the area of expert systems has shown that artificial intelligence techniques can be of real use in practical real-world problem areas like medical diagnosis, geological research and chemical identification. Perhaps because of the success of expert systems, which typically require the processing of large amounts of information, the belief is widespread that microcomputers are inadequate for AI work. We disagree. We believe that there are AI problems waiting to be solved via microcomputer, and we conceive this competition to challenge the brightest microcomputer programmers we know of — *Dr. Dobb's* readers — to find and solve some of those problems. A fantasy? Perhaps. But *Dr. Dobb's Journal* has been publishing Realizable Fantasies since 1976.

The Rules: The following items must be included in each entry: a functioning program on disk, a well-documented listing of the program, a prose description of the program explaining what it does and how it does it, and the entrant's name and address. The program must be written in a high-level language for a microcomputer, and the entry must be postmarked no later than September 30, 1984 and received by October 30, 1984 (*overseas entrants take note*).

Although your choice of specific language, hardware, problem domain and approach to the problem are all open, we offer some guidelines as to how we will be judging the entries. Your program will be judged for originality and significance of contribution first, and second on its intrinsic merits as a program: modularity of design, efficiency, portability, clarity, and so on. A program that executes in 64K of memory will get higher marks than an equivalent program that requires 96K, but a 128K program that does significantly more may rate higher than either. If your choice of hardware or disk format is an unusual one, you might query us before submitting your entry.

The Payoff: The winner will receive a \$1000 prize and will have the program and prose description published in *Dr. Dobb's*. In the tradition of *Dr. Dobb's*, this contribution to the advance of microcomputer software is to be placed in the public domain with full credit to the author. Support for the concept of public domain software is part of *Dr. Dobb's* heritage, but it may not be part of yours. This competition is for those who genuinely want to make a contribution to the advance of microcomputer software. Send your entry to:

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16-BIT SOFTWARE TOOLBOX

by Ray Duncan

Professional Basic

Neil Bennett's outstanding BASIC implementation for the IBM PC, called "Professional Basic," is now available through Morgan Computing Company, Inc. (10400 North Central Expressway, Suite 210, Dallas, TX 75231). This version of the language sets new standards with its fantastic window-oriented debugging tools, dynamic syntax checking, use of the Intel 8087 numeric co-processor for fast floating-point operations, and support for the 8086/88 CPU's full 1-megabyte address space for both programs and data. The user interface has a distinctive, elegant style that is unbeatable for program development. For more details, read the review in the April 1984 issue of *Byte* magazine. If you own an IBM PC, and must program in BASIC for whatever reason, you owe it to yourself to pick up the phone and order a copy of Professional Basic. Users of other machines take heart; versions are being contemplated for most of the popular 16-bit microcomputers including 68000-based machines.

The Filepath Utility

"Filepath," a small but indispensable utility from SDA Associates (P.O. Box 36152, San Jose, CA 95158), has changed my life for the better. Written by Bernie Belew and selling for the miniscule fee of \$12.95 plus tax, Filepath does for data files what the MS-DOS "Path" command does for executable program files. This is extremely helpful when using programs that refer to the disk for overlays, messages, and the like. For example, you can now put one copy of WordStar and its overlay files into a single subdirectory on your hard disk, point to that subdirectory with "Path=" and "Filepath=" specifications in your AUTOEXEC.BAT file, and use the word processor successfully from anywhere in the directory structure.

Beating the Laws of Thermodynamics

Those of you with a taste for computing esoterica might like to read the article "Computing without Dissipating Energy," in *Science* (March 16, 1984, page 1164). When I was a chemistry major, the Three Laws of Thermodynamics were taught to us as: (1) You can't get something for nothing, (2) You can't break even until you get to absolute zero, and (3) You can't get to absolute zero. There is now a heated (if you'll excuse the ex-

pression) debate going on between one group of physicists who believe computation inherently requires the expenditure of energy and some scientists who think the energy dissipation per logical operation could be brought arbitrarily close to zero with radically different technology. If you're interested, brush up on your Turing machine theory and lose yourself within the pages of *Science*.

Floating-Point Benchmarks

Results continue to flow in on the Bill Savage floating-point benchmark recently published in this column. In spite of its deficiencies, this benchmark seems to have sparked an incredible amount of reader interest. Versions for two of the "missing" languages, LISP and Logo, have been contributed and may be found in Listings One and Two (page 83). I plan to publish a corrected and expanded list of timings and errors within the next three months.

Mark Seage of Lawrence Livermore Labs came through with results for the Cray I and Cray X-MP processors and certainly made me eat my words about the performance of 8086/8087-based microcomputers compared to mainframes. The timing for the latter, incidentally, was an incredible 0.00012 seconds with an absolute error of 1.7E-10. He notes that this particular benchmark cannot be vectorized, but that in a benchmark that *was* vectorizable an additional speedup of 10 to 100 times could be expected. Now that I am confronted with an example of the number-crunching performance of a *real* mainframe that I can relate to, I must admit to being a bit awed.

At the other end of the computer spectrum, Jim Benenson wrote to defend the reputation of the Sinclair ZX-81. This machine's BASIC was previously reported to complete the Savage benchmark in about 1 day. Jim observed an execution time of 935 seconds in "fast mode" and an absolute error of 3.0E-1.

An error occurred in my transcription of the result for WS Systems Forth running on the 8086 with 8087 support. The actual error was 2E-13, not 1E-3 as printed in the column.

In the course of their comments on the original benchmark program, several readers have recommended *Software Manual for the Elementary Functions*, by William Cody Jr. and William Waite (Prentice Hall Inc., 1980). The book sells

for about \$20, and is "designed to help a programmer without a degree in numerical analysis implement the elementary mathematical functions," says Delbert Franz. It gives approximations for a variety of precisions and includes detailed flow charts and notes for a variety of floating-point bases ... as well as for fixed-point machines."

More on the Microsoft 8086 Assembler

My earlier column on some "anomalies" in the Microsoft Macro Assembler provoked a few indignant letters and some reports of further bugs. Several people came to the defense of the Assembler, saying that some of the problems that I considered bugs were simply artifacts of its internal storage format for variables. One person even stated that the Microsoft Assembler's display of word values in the opposite byte order from the actual physical storage in memory was "not a bug, but a feature!"

Sorry folks, I just can't agree. When you are using an assembler, you are working at the machine level and can expect to be staring at plenty of object code dumps while debugging. If the listing doesn't correspond *exactly* to what's in memory, it's only adding to your mental workload and creating unnecessary opportunities for additional errors. The same argument applies to the representation of the actual binary value of equates. If Microsoft wants to promulgate a philosophy of writing assemblers that is different from everyone else in the world, it could at least warn us in the manual.

Dan Rollins, author of an excellent assembly language column in *PC Age* magazine, writes, "There is another very nasty bug [in the Microsoft Assembler] that can cost hours of debugging. That is, when the symbol in

ADD reg/mem16,offset symbol

has a segment offset of less than 128, the assembler generates the sign-extended version of the addressing mode byte. This is very considerate — it saves an entire byte in the executable module. However, the reference that's generated is not relocatable. Therefore if the position of the specified data changes during the link process, you end up with a logic error that's not your fault. The same problem exists for SUB, AND, CMP, OR, etc., when the address operand just happens to be early in the module.

"Here's a handy hint for your readers.

Sometimes when you link a bunch of modules, you want to be sure that their segments will be loaded into memory in a specific order. For instance, you may want your DATA_SEG to come after your CODE_SEG. Alas, the physical placement of the segment in the source code has no effect on the placement in memory. The undocumented way to do this is to name your segments so that they are alphabetically in the order that you want them in memory. But, this only applies to segments in a single module.

"The Linker documentation clearly states that the overriding priority of segment placement is the order in which the object modules are named in the LINK command line. You can let that foul you up, or you can use it to your advantage.

"First, create several OBJ modules that each define an empty segment. For instance, one module would look like this:

```
; ** dummy module DATA_MOD.OBJ
data_seg segment public
data_seg ends
end
```

"DATA_SEG would be the same name as a segment in the module you

want to reorganize. Then have the linker load these 'dummy modules' before loading the real code:

```
LINK code_mod+stack_mod
+data_mod+myprog;
```

"Rearranging the order of the dummy modules also rearranges the placement of the modules in memory. Verify it by reading the link map.

This technique is most useful when using the GROUP pseudo-op for creating COM format files. Often you'll want to define your data at the top of a program in order to avoid the phase errors and 'Operand must have size' errors that can happen when you have forward references in your code."

Page 5-40 of the Microsoft Assembler manual alludes to another way of controlling the placement of a segment. The "MEMORY" combine-type entry on a segment declaration is supposed to force that segment to be loaded at a higher address than all other segments being linked together. However, it doesn't work as advertised — just another "feature," I guess.

One particularly amusing report came

from a user who found that mistyping "para" as "par" in a segment declaration can cause the Microsoft Assembler to crash without any warning or error message. The mechanism by which this could be occurring is hard to imagine. After all, the source file is, from the assembler's point of view, simply a data structure to be transformed, right? It's a good thing our word processors don't crash every time we misspell a word!

Toolbox Installment

Listing Three (page 84) contains a set of three interdependent subroutines to convert a word or byte into the equivalent hexadecimal ASCII representation. The routines are written in a form suitable for the Microsoft 8086 Assembler, though the code should also be acceptable with little or no change to Digital Research or Intel assemblers.

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16-Bit Listing One

Logo version of the Savage benchmark, adapted from program contributed by Tom Prince.

```
to savage ;Savage benchmark in LOGO
make "a 1
repeat 2500 [make "a (tan atan exp ln sqrt :a*:a 1) +1]
;note that LOGO atan is like FORTRAN atan2
(print [a = [ :a)
end

to tan :x
output (sin :x)/(cos :x)
end
```

End Listing One

Listing Two

LISP version of the Savage benchmark, contributed by Morton Goldberg.

```
~
~ An IQ LIST version of Savage's Benchmark Program
~
(DEF 'BMRK
  '[LAMBDA (N)
    (OR N (SETQ N 2500))
    [PROG (A)
      [SETQ A 1.0D)
```

(Continued on next page)

16-Bit (Listing Continued, text begins on page 82)

Listing Two

```
LOOP
  (SETQ A (+ 1.0D
    (TAN (ATAN (EXP (LN (SQRT (* A A ) T) T) T) T) T)))
  (SETQ N (SUB1 N))
  (COND [(LE N 0) (RETURN (SUB1 A))])
  (GO LOOP))])
```

End Listing Two

Listing Three

```
;
; Intel 8086 subroutines to convert a binary
; word or byte to hexadecimal ASCII format.
; Ray Duncan, March 1984.
;
word_to_hex proc near          ;convert 16-bit binary word
                                ; to hex ASCII
                                ;call with AX=binary value
                                ;
                                ;       DI=addr to store string
                                ;       (4 characters)
                                ;returns AX, DI, CX destroyed

    push    ax
    mov     al,ah
    call    byte_to_hex        ;convert upper byte
    pop     ax
    call    byte_to_hex        ;convert lower byte
    ret

word_to_hex endp

byte_to_hex proc      near      ;convert binary byte to hex ASCII
                                ;call with AL=binary value
                                ;
                                ;       DI=addr to store string
                                ;       (2 characters)
                                ;returns AX, DI, CX destroyed

    sub     ah,ah              ;clear upper byte
    mov     cl,16
    div     cl                  ;divide binary data by 16
    call    ascii              ;the quotient becomes the first
                                ;ASCII character, store it.
    mov     al,ah
    call    ascii              ;the remainder becomes the
                                ;second ASCII character, store it.
    ret

byte_to_hex endp

ascii    proc      near        ;convert bottom 4 bits in AL
                                ;into the hex ASCII character

    add     al,'0'
    cmp     al,'9'
    jle     ascii2
    add     al,'A'-'9'-1
    ;jump if in range 0-9,
    ;offset it to range A-F,
    ;return ASCII char. in AL.

ascii2:  ret

ascii    endp
```

End Listings

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by Anthony Skjellum

In previous columns, I have alluded to 8086-family C compilers that support large-memory models. Before discussing some of the compilers that provide such features, I thought it worthwhile to discuss the memory model concepts of the 8086 and how these concepts impact C compilers implemented for this microprocessor family. I will discuss the advantages and drawbacks of several memory models used by existing C compilers, and present code to help overcome some of the limitations of small-memory model compilers.

For those readers who are not interested in the details of 8086 C compilers, large-memory models, or long pointers, there is still some interesting material in this column. Specifically, several routines that are included here illustrate real-life code that will interface C and assembly language. Most compiler manuals are terse on this subject, so some actual code may help drive home the concepts involved.

Background

Before plunging into a discussion of memory models, a brief introduction to the 8086 architecture is necessary. This material will help to illustrate why different compilers use different addressing schemes.

The 8086/88 microprocessors support 20-bit addressing. This fact allows the microprocessor to address in excess of 1 million bytes. All the registers are 16 bits wide, however. This implies that some segmentation scheme must be used in order to address more than 64K of memory. The technique used involves four 16-bit segment registers: CS, DS, ES, and SS. These registers are the code-segment, data-segment, extra-segment, and stack-segment registers, respectively. Depending on the instruction used, different segment registers come into play in determining the complete 20-bit address. In forming a complete address, the segment address is always shifted left four bits. Note that a segment register by itself addresses memory on 16-byte boundaries. Sixteen-byte regions addressable by segment registers are known as paragraphs. Although paragraphs and paragraph alignment are not normally of interest to C programmers, they are sometimes important when developing assembly-language interface code for C.

When discussing long pointers, a special notation is used. Because the address is split, it is written in the form:

segment:byte_pointer

where *segment* is the segment, and *byte_pointer* is the 16-bit, low-order part of the address. A typical example of such an address would be "es:bx," which means "segment specified by es register and offset from this segment specified by the bx register." This notation is used throughout the listings included with this column.

Machine instructions often differentiate between inter- and intrasegment operations. For example, there are "near" and "far" CALL instructions.

I will now outline several memory models.

8080 Memory Model

The 8080 memory model is just what its name implies. All segment registers are set equal, so that only a total of 64K is available for a program. This model is seen mostly under CP/M-86 but is occasionally used by MS-DOS programs. None of the C compilers that I have seen restrict programs to this model.

Small-Memory Model

Many programs can work comfortably with only 64K of data space and 64K of program space. Such a model results when the CS and DS registers are set to different blocks of memory (up to 64K each). Normally, ES and SS are set equal to DS, so that all data and stack memory resides in the same block of memory. This model is fine as long as programs and data requirements are small enough to fit within the 64K limits. Most C compilers support only this model.

Large-Memory Model

In a large-memory model, all addresses refer to the full 20-bit range. All subroutine calls are "far" calls, and all data is referred to with long pointers. Long pointers include a segment- and byte-address pointer (thus occupying 32 bits). Only a few C compilers support this model. The reason that most compilers don't support this model is its complex code generation. I will mention more on this later.

Hybrid

A useful hybrid of the small- and the large-memory models is the one where only 64K of program space is provided but long pointers for data are used. This model offers speed advantages for programs that require more data storage but are moderately small.

One other possibility would be a large-code/small-data model, which would be used for programs with small data requirements but large code requirements.

One type of model that has not been considered is one that supports a large stack. A large stack would support more than 64K of items. Implementing this feature would slow program execution significantly, because stack references would be complicated.

Which Model Is Better?

As long as a C program can fit within the small-memory model, there is a distinct speed advantage in using this model. The large-memory model produces longer (and somewhat slower) programs because of the greater generality of each instruc-

```
typedef union    __lptr
{
    long        _llong;        /* long format */
    char        _lstr[4];      /* character format */
    WORD        _lword;        /* long-word format */
} LPTR;
```

Figure 1.

```
typedef struct    __lword
{
    unsigned    _addr;        /* address */
    unsigned    _segm;        /* segment */
} LWORD;
```

Figure 2.

tion produced (ability to refer to 1024K instead of 64K of memory requires longer pointers and more checks). Because the 8086 doesn't provide many instructions to manipulate the long pointers, many additional instructions must be generated for pointer-related operations (which also include all memory references).

Specific examples of the lack of 8086 instructions involve incrementing and decrementing long pointers. Note that a long pointer is not just a 32-bit word. The upper 16 bits is a segment address that must be treated accordingly when crossing 64K boundaries. Examples of implementing these features in software are included in Listing Five (1lint.asm: examples: linc and ldec functions, page 96).

Thus, both models have drawbacks. Speed is gained at the expense of (essentially) unlimited program and data space. Use the large-memory model for big programs that use big chunks of data. Otherwise, stick with the small model.

Drawbacks of the Small-Memory Model

Assuming that you use the small-memory model (by choice or because of your compiler), everything will run smoothly until it becomes necessary to deal with memory outside of the C data-address space. For example, it might be nice to use large buffers for copying files or for keeping help information. Another possibility would involve accessing special locations in the memory map.

The ability to use long pointers in a small-memory model can be implemented with relative ease. A set of such routines is presented in Listings One through Five (pages 88-104). A description of the Long Pointer Package and applications for the package form the remainder of this column.

The Long Pointer Package

The Long Pointer Package supplements a C environment by allowing references to memory locations to occur anywhere in the 20-bit address map. This is done by defining a new data type, LPTR (via a typedef), as shown in Figure 1 (page 86) where LWORD is defined as the structure shown in Figure 2 (page 86). This format for LPTR makes the addresses defined directly compatible with normal long pointers used at the assembly level. These long pointers are stored in the 8080 style: least-significant byte of address first, most-significant byte of segment last.

The lowest-level routines that support long memory references are, of necessity, coded in assembly language. The routines that implement many of the lowest-level functions in a noncompiler-specific way are included in Listing Four (l1sup.asm). Routines that implement functions for Aztec C86 (a typical 8086 C compiler) Version 1.05i are included in Listing Five

(l1int.asm). The user may have to modify these routines to work with other C compilers if register usage or stack arrangements differ.

In order to actually use the routines with C programs, the header file "l1sup.h" must be included at the beginning of modules that use or refer to LPTR data types. The "l1sup.h" file refers to "_l1sup.h" also. These two headers are presented in Listings Two and Three, respectively.

Supported Functions

The package supports a number of functions involving long pointers. There are routines to add offsets to long pointers and to copy memory between long pointers and routines to return data addressed by long pointers. A complete list of these functions is included in Table I (below). In this table, the file in which the function is located is mentioned.

An Example

One useful application of long pointers under MS-DOS 2.0 involves accessing a program's environment block. The environment block is a Unix-like set of environment variables and values. This is normally used to affect some particular aspects of program execution. Specifics about the environment address are included in the inset on page 88. Interested readers should also refer to the DOS 2.0 users' manual for more details.

The example program env.c reads the environment block and displays the contents of the whole block on the console. In effect, it provides the same listing feature as the MS-DOS SET command.

Conclusion

In this column I have discussed various aspects of memory models for 8086 C compilers. I have included a set

file: l1sup.c (some C support routines)

lassign(dest,source)	assign long pointers
llstrcpy(dest,source)	long string copy
lprint(lptr)	debugging routine for printing LPTRs

file: l1int.asm (Aztec C dependent support routines)

flptr(lptr,sptr)	form a long pointer from a normal short C (ds relative) pointer
lchr(lptr)	return character addressed by long pointer
lint(lptr)	returns int/unsigned addressed by long pointer
l_stchr(lptr,chr)	stores char at location lptr.
l_stint(lptr,intgr)	stores int at location lptr.
lload(dest,lptr,len)	general purpose copy to short pointer area (ds relative) from long pointer area reverse if lload()
lstor(lptr,src,len)	increment long pointer
linc(lptr)	decrement long pointer
ldec(lptr)	add unsigned offset to lptr
ladd(lptr,offset)	subtract unsigned offset from lptr
lsub(lptr,offset)	add signed offset to lptr
lsum(lptr,offset)	general purpose long to long copy (can copy up to 1024K of memory)
lcopy(dest,src,len)	

file: l1sup.asm (compiler independent functions)

linc	increment a long pointer
ldec	decrement a long pointer
ladd	add an unsigned offset to a long pointer
lsub	sub an unsigned offset from a long pointer
lsum	add a signed offset from a long pointer
lcopy	general copy routine

Table 1.

Environment Block Address

C compilers under MS-DOS normally produce .EXE files. For .EXE files, a program-segment prefix is created by DOS 2.0 and higher. The segment address of this prefix is es:0 when the user program begins. At offset 002CH from this address is stored the segment address of the environment table. Only a segment is stored: the offset from the segment is again zero. Thus, the contents of es:2CH is the address of the environment block.

Normally, C compilers have a maintenance routine that is given control at the start of program execution. In Aztec C86, this routine is called \$begin and is located in the calldos.asm module included with the compiler. The user must define an external variable in calldos.asm for the benefit of env.c for the segment address to be accessible as a long pointer. The procedure for this operation is detailed in the comments included in Listing Six (env.c, page 104).

Allocation of Memory

If a C program intends to use DOS memory allocation in conjunction with the long pointers, it must also be sure to shrink its memory allocation, using the MS-DOS SETBLOCK function. This is normally done in the initial maintenance routine of the C runtime system. In Aztec C, this must be done in \$begin.

of C and assembly-language functions that supports long pointers under a small-memory-model environment. With this package, users can enjoy the best of both worlds: access to arbitrary amounts and locations of memory, while retaining the efficiency of short pointers for regular code and pointer operations. For users of compilers that only support the small model, this package allows access to features that were previously off-limits to 8086 C programmers.

■ ■ ■

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C/UNIX (Text begins on page 86) Listing One

```

/*****
*
*      lsup.c                      created: 25-Mar-84
*
*      long pointer support for small memory model 8086 C compilers.
*
*      version 1.00 as of 25-Mar-84
*
*      Copyright 1984 (c) Anthony Skjellum.
*      All rights reserved.
*
*      This program may be freely distributed for all non-commercial
*      purposes, but may not be sold.
*
*      The routines contained here are designed to be portable to
*      a large variety of compilers. Currently they have been tested
*      with Aztec C86 v 1.05i only.
*
*      Modules comprising this package:
*
*          lsup.c          this file.
*          lsup.h          header/definition file.
*          _lsup.h         lower level header for this file
*          llsup.asm       assembly language support (compiler
*                          independent)
*          llint.asm       compiler interface code (compiler
*                          dependent)
*
*      Subroutines included here:
*      (those marked with an asterisk are only included if compiler
*       used lacks some preprocessor support feature)
*
*****/
```

```

#include "_lsup.h"                /* header with definitions */

/*
    Special routines: Included only if compiler lacks one of
    several features.
*/

/* lassign(dest,source): assignment of type LPTR to the left */

#ifndef MSUBST

lassign(dest,source)
LPTR dest;
LPTR source;
{
    dest._llong = source._llong;    /* assignment */
}

#endif

/*
    General purpose routines:
*/

/* llstrcpy(dest,src): copy null terminated strings between long ptrs */

llstrcpy(dest,src)
LPTR *dest;
LPTR *src;
{
    char chr;                      /* temporary */
    while(1)                       /* loop */
    {
        chr = lchr(&src);          /* get a character */
        l_stchr(&dest,chr);        /* store a character */

        linc(&dest);               /* increment destination ptr */
        linc(&src);                /* and source pointer */

        if(!chr)                   /* we are done at eos */
            break;
    }
}

/* debugging routines: */

lprint(lptra)
LPTR *lptra;
{
    printf("%lx",lptra->_llong);
}

```

End Listing One

Listing Two

```

#include "_lsup.h"

/* place any special function specifications (defined in lsup.c) here: */

```

End Listing Two

(Listing Three begins on next page)

Listing Three

```

/*****
*
*      _lsup.h                      created: 25-Mar-84
*
*      a component of lsup.c
*
*      version 1.00 as of 25-Mar-84
*
*      Copyright 1984 (c) Anthony Skjellum.
*      All rights reserved.
*
*      This program may be freely distributed for all non-commercial
*      purposes, but may not be sold.
*
*      This is a header/definition file which must be included
*      in any module which utilizes long pointers.
*
*****/

/*
    compiler feature toggles:
    comment out any which don't apply to the compiler in use.
*/

#define MSUBST                      /* macro substitution supported */

/* typedefs */

typedef struct __lword
{
    unsigned _addr;                /* address */
    unsigned _segm;                /* segment */
} LWORD;

typedef union __lptr
{
    long     _llong;                /* long format (for assignments) */
    char     _lstr[4];             /* character format */
    LWORD    _lword;               /* long-word format */
} LPTR;

/* constants */

/* macros */

/* lassign(destination,source): effect assignment of type LPTR */

#ifdef MSUBST
#define lassign(d,s)      d._llong = s._llong;
#endif

/* function specifications: */

char lchr();
```

End Listing Three

(Listing Four begins on page 92)

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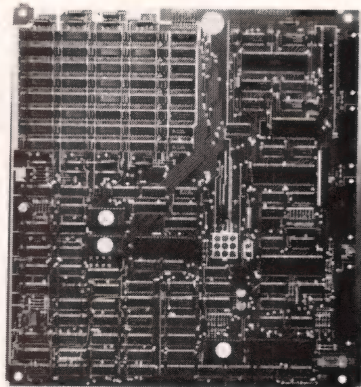
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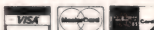
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Listing Four

```
;
; llsup.asm
;
; a component of lsup.c
;
; Copyright 1984 (c) A. Skjellum. All rights reserved.
;
; version of 25-Mar-84
;
; This routine makes no assumptions about the behavior of the
; C compiler in use.
;
; all procedures are "near"
;

dseg      segment para public 'data'
dseg      ends

cseg      segment para public 'code'
          assume  cs:cseg,ds:dseg

;
; linc:          increment a long pointer by 1 byte
;
; expects:      es:bx with long pointer to increment
; returns:      pointer incremented.
; consumes:     es, bx, f, ax
;
;      public   linc
linc      proc   near
          inc    bx          ; increment low part of word
          or     bx,bx       ; is it zero now?
          jnz    linc_exit   ; no, we are done
          mov     ax,es
          add     ax,1000h    ; another 64k of paragraphs
          mov     es,ax      ; store back to es
linc_exit:
          ret              ; return
linc      endp

;
; ldec:          decrement a long pointer by 1 byte
;
; expects:      es:bx with long pointer to decrement
; returns:      pointer decremented.
; consumes:     es, bx, f, ax
;
;      public   ldec
ldec      proc   near
          or     bx,bx       ; zero currently ?
          dec     bx         ; decrement it
          jnz    ldec_exit   ; just decrement low end and exit...
          mov     ax,es      ; get segment register
          sub     ax,1000h    ; remove 64k of paragraphs
          mov     es,ax      ; store back to es
ldec_exit:
          ret              ; return
ldec      endp
```

```

;
; ladd:          add a constant to a long pointer
;
; expects:       es:bx with long pointer's original value
;               ax with unsigned constant to be added
; returns:       pointer with constant added
; consumes:      es, bx, f, ax
;
;               public ladd
ladd      proc    near
            add    bx,ax          ; add in offset
            jnc    ladd_exit      ; no carry, so we are done.
            mov    ax,es
            add    ax,1000h        ; add 64k of paragraphs
            mov    es,ax          ; and store back to es
ladd_exit:
            ret
ladd      endp

;
; lsub:          subtract a constant from a long pointer
;
; expects:       es:bx with long pointer's original value
;               ax with unsigned constant to be subtracted
; returns:       pointer with constant subtracted
; consumes:      es, bx, f, ax
;
;               public lsub
lsub      proc    near
            sub    bx,ax          ; subtract offset
            jnb    lsub_exit      ; no borrow, so we are done.
            mov    ax,es
            sub    ax,1000h        ; subtract 64k of paragraphs
            mov    es,ax          ; and store back to es
lsub_exit:
            ret
lsub      endp

;
; lsum:          add a signed offset to a long pointer
;
; expects:       es:bx with long pointer
;               ax with signed offset
; returns:       pointer with constant added (signed)
; consumes:      es, bx, f, ax
;
;               public lsum
lsum      proc    near
            or     ax,ax          ; negative?
            jm     lsum_neg
            call   ladd           ; do addition
            ret                 ; and exit
lsum_neg:
            and    ax,07ffffh    ; and out sign flag
            jnz    lsum_neg_ok
            mov    ax,8000h      ; -32768 value (don't treat as 0)
lsum_neg_ok:
            call   lsub
            ret
lsum      endp

;
; lcopy:         copy from one long pointer to another,

```

(Continued on next page)

Listing Four

```

;          up to 1024k bytes of data
;
; expects:  ds:si with src  address
;          es:di with dest address
;          ds:cx with length (dx is high order, cx is low order)
;
; returns:  block copied
;          ds, es intact
; consumes: ax, cx, f
;
;
; this routine uses a copy downward method, to produce
; correct copying for overlapping regions
;
;
; public lcopy
lcopy proc near
;
; convert dx into segment form:
;
push    dx          ; save original form of dx
push    cx          ; save low order of long count
and     dx,15       ; smallest meaningful value
xchg    dh,dl       ; switch upper and lower parts
mov     cl,4
shl     dh,cl       ; effect is shift left by 12 bits
pop     cx          ; and recover low order of long count
;
mov     ax,es
add     ax,dx
mov     es,ax
mov     ax,ds
add     ax,dx
mov     ds,ax      ; gross adjustment of segments
pop     dx          ; recover original form of dx
;
add     di,cx       ; adjust dest. ptr to end of area
jnc     no_dest_adj
mov     ax,es
add     ax,1000h    ; add offset
mov     es,ax      ; and store back to segment register
no_dest_adj:
;
; do same work for source pointer:
;
add     si,cx       ; do the addition
jnc     no_mor_adj  ; no more adjustment needed if no carry
mov     ax,ds
add     ax,1000h    ; do the adjustment
mov     ds,ax      ; and store back to ds
;
; at this stage:
;
;          es:di is at the last byte of the dest. area
;          ds:si is at the last byte of the src. area
;
no_mor_adj:
std                     ; set direction flag for moves
lc_loop:
or      si,si         ; is si zero ?

```

(Continued on page 96)



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- Upper/lower case optionally significant
- Conditional assembly
- Assemble code for execution at another address (PHASE & DEPHASE)
- Generates COM, HEX, or REL files
- COM files may start at other than 100H
- REL files may be in Microsoft format or SLR format
- Separate PROG, DATA & COMMON address spaces
- Accepts symbol definitions from the console
- Flexible listing facility includes TIME and DATE in listing (CP/M Plus Only)

- Links any combination of SLR format and Microsoft format REL files
- One or two pass operation allows output files up to 64K
- Generates HEX or COM files
- User may specify PROG, DATA, and COMMON loading addresses
- COM may start at other than 100H
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Listing Four

```
        lodsb             ; get byte ds:[si], decrement si
        jnz      no_ds_adj ; no need to adjust if non-zero at start
        mov       ax,ds
        sub       ax,1000h
        mov       ds,ax    ; adjust pointer for next load
no_ds_adj:
        or        di,di    ; is di zero ?
        stosb      ; set byte es:[di] = al, decrement di
        jnz      no_es_adj ; no need to adjust if non-zero at start
        mov       ax,es
        sub       ax,1000h
        mov       es,ax    ; adjust pointer for next store
no_es_adj:
        loop      lc_loop  ; copy whole block (--cx, jnz lc_loop)
        dec       dx       ; work on outer loop
        or        dx,dx
        jnz      lc_loop  ; loop over dx counts too
        ;
        ; we are done
        ;
        inc       si
        inc       di       ; restore to original calling values
        ret        ; exit
lcopy   endp

cseg    ends
end
```

End Listing Four

Listing Five

```
;
; llint.asm
;
; version of 25-Mar-84
;
; a component of lsup.c
;
; Copyright 1984 (c) A. Skjellum. All rights reserved.
;
; these routines are setup for Aztec C86 v 1.05i
;
; all procedures are "near"
;

dseg    segment para public 'data'
dseg    ends

cseg    segment para public 'code'
        assume  cs:cseg,ds:dseg,es:dseg,ss:dseg

;
; Routines which do not merit calls to portable routines in llsup.asm
;
```

```

;
; ds = flptr(lptra,sptra)
; LPTR *lptra;
; char *sptra;
;
; form a long pointer from a "normal" ds relative short pointer (sptra)
; and store at lptra
;
; note: no portable segment (flptr) in llsup.asm since this
; is such a trivial routine.
;
; return value is also ds, should this prove useful
;
        public  flptr_
flptr_  proc    near
        mov     bx,sp                ; prepare for argument load
        mov     ax,4[bx]            ; get short pointer ds:ax
        mov     bx,2[bx]            ; get address where to store long pointer
        mov     [bx],ax              ; store low order
        mov     ax,ds
        mov     2[bx],ax            ; store high order
        ret                                     ; return value is also ds
flptr_  endp

;
; the following four routines are examples of what can
; be done to supplement general routines with specific
; (more efficient ones). Many more variations are
; possible than the two presented here. They follow
; directly from this basic idea:
;
;
; char lchr(lptra)
; LPTR *lptra;
;
; return character pointed to by lptra
;
        public  lchr_
lchr_   proc    near
        mov     bx,sp                ; prepare for argument load
        push    ds                    ; save ds register
        mov     bx,2[bx]            ; get address of lptra
        mov     ax,[bx]              ;
        mov     ds,2[bx]            ; begin forming pointer
        mov     bx,ax                ; ds:bx now is valid pointer
        sub     ax,ax                ; zero whole acc.
        mov     al,[bx]              ; get the character
        pop     ds
        ret                                     ; exit with char in ax
lchr_   endp

;
; int lint(lptra)
; LPTR *lptra;
;
; return integer or unsigned pointed to by lptra
;
        public  lint_
lint_   proc    near
        mov     bx,sp                ; prepare for argument load
        push    ds                    ; save ds register
        mov     bx,2[bx]            ; get address of lpr
        mov     ax,[bx]              ;

```

(Continued on next page)

Listing Five

```

        mov     ds,2[bx]      ; begin forming pointer
        mov     bx,ax         ; ds:bx now is valid pointer
        mov     ax,[bx]      ; get the integer or unsigned
        pop     ds           ; recover old ds value
        ret              ; and exit with char in ax
lint_   endp

;
; l_stchr(lptra,chr)
; LPTR *lptra;
; char chr;
;
; store character chr at address lptra
;
        public  l_stchr_
l_stchr_ proc   near
        mov     bx,sp         ; prepare for argument load
        mov     cx,4[bx]     ; get character
        mov     bx,2[bx]     ; prepare for load of long pointer
        push    ds           ; save ds segment register
        mov     ax,[bx]      ;
        mov     ds,2[bx]     ; begin forming pointer
        mov     bx,ax         ; ds:bx now is valid pointer
        mov     [bx],cx      ; store byte
        pop     ds
        ret
l_stchr_ endp

;
; l_stint(lptra,val)
; LPTR *lptra;
; int val;
;
; store integer or unsigned at address lptra
;
        public  l_stint_
l_stint_ proc   near
        mov     bx,sp         ; prepare for argument load
        mov     cx,4[bx]     ; get integer to store
        mov     bx,2[bx]     ; prepare to form ds:bx with correct
                                ; storage address
        push    ds           ; save current ds
        mov     ax,[bx]      ;
        mov     ds,2[bx]     ; begin forming pointer
        mov     bx,ax         ; ds:bx now is valid pointer
        mov     [bx],cx      ; store the integer
        pop     ds
        ret              ; exit
l_stint_ endp

;
; lload(dest,lptra,len)
; char *dest;
; LPTR *lptra;
; unsigned len;
;
; general purpose copy routine from long data storage to ds: relative
; storage

```

(Continued on page 100)

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Listing Five

```
;
; we assume es = ds for Aztec C explicitly here
;
; due to convenient 8086 instructions, the portable function would
; consist merely of a "cld", "rep movsb" sequence followed by a return.
; Therefore, no portable lload is included in llsup.asm
;

lload_    public  lload_
lload_    proc    near
    mov     bx,sp                ; prepare for argument load
    push    ds                  ; save Aztec ds segment
    push    si
    push    di                  ; save source and destination indices
    ;
    mov     cx,6[bx]             ; get length for move
    mov     di,2[bx]             ; es:di now has the destination address
    mov     bx,4[bx]             ; prepare to load long ptr
    mov     si,[bx]              ; get low order
    mov     ds,2[bx]             ; and then high order
    cld
    rep     movsb                ; do the move
    pop     di
    pop     si
    pop     ds
    ret
lload_    endp

;
; lstor(lptr,src,len)
; LPTR *lptr;
; char *src;
; unsigned len;
;
; Reverse of lload: this routine copies data from ds:src to lptr
; Once again, there is no llsup analog.
;

lstor_    public  lstor_
lstor_    proc    near
    mov     bx,sp                ; prepare for argument load
    push    es
    push    di
    push    si                  ; save registers as required by Aztec C.
    mov     cx,6[bx]             ; get length of move
    mov     si,4[bx]             ; ds:si now contains source index
    mov     bx,2[bx]             ; prepare to form es:di
    mov     di,[bx]
    mov     es,2[bx]
    rep     movsb                ; move the data
    pop     si
    pop     di
    pop     es
    ret                          ; restore registers and exit
lstor_    endp

;
; -----
;
; routines which call portable subroutines in llsup.asm
```

```

;
; -----
;
; linc(lptr)
; LPTR *lptr;
;
; increment a long pointer by 1
;
;
; public linc_
linc_  proc    near
; extrn linc:near
; mov    bx,sp          ; prepare for argument load
; push   es             ; save es value from caller
; mov    bx,2[bx]
; push   bx             ; address where answer will go
; mov    es,2[bx]       ; get segment
; mov    bx,[bx]        ; and address
; call   linc           ; do the work
; pop    ax
; xchg   ax,bx
; mov    [bx],ax
; mov    2[bx],es       ; store the value
; pop    es             ; recover the old value
; ret                    ; and exit
linc_  endp

;
; ldec(lptr)
; LPTR *lptr;
;
; decrement a long pointer by 1
;
;
; public ldec_
ldec_  proc    near
; extrn ldec:near
; mov    bx,sp          ; prepare for argument load
; push   es             ; preserve es
; mov    bx,2[bx]       ; get address ds:bx
; push   bx             ; address where answer will go
; mov    ax,[bx]
; mov    es,2[bx]
; mov    bx,ax
; call   ldec           ; do the decrement
; pop    ax
; xchg   ax,bx
; mov    [bx],ax
; mov    2[bx],es       ; store the value
; pop    es             ; recover it for sake of caller
; ret                    ; and then exit
ldec_  endp

;
; ladd(lptr,offset)
; LPTR *lptr;
; unsigned offset;
;
; add unsigned offset to a long pointer
;
;
; public ladd_
ladd_  proc    near
; extrn ladd:near
; mov    bx,sp          ; prepare for argument load
; push   es             ; save es value of caller
; mov    ax,4[bx]       ; get the offset to ax

```

(Continued on next page)

Listing Five

```
    mov     bx,2[bx]
    push    bx                ; address where answer will go too.
    mov     cx,[bx]
    mov     es,2[bx]
    mov     bx,cx
    call    ladd              ; do the addition
    pop     ax
    xchg    ax,bx
    mov     [bx],ax
    mov     2[bx],es          ; store the value
    pop     es                ; recover old es value
    ret                          ; and then exit
ladd_     endp
```

```
;
; lsub(lptr,offset)
; LPTR *lptr;
; unsigned offset;
;
; subtract unsigned offset from a long pointer
;
```

```
    public  lsub_
lsub_     proc      near
    extrn  lsub:near
    mov     bx,sp            ; prepare for argument load
    push    es               ; preserve es
    mov     ax,4[bx]         ; get the offset
    mov     bx,2[bx]
    push    bx               ; store answer at this addr. too.
    mov     cx,[bx]
    mov     es,2[bx]
    mov     bx,cx
    call    lsub              ; do the subtraction
    pop     ax
    xchg    ax,bx
    mov     [bx],ax
    mov     2[bx],es         ; store the value
    pop     es               ; restore es
    ret                          ; and then exit
lsub_     endp
```

```
;
; lsum(lptr,offset)
; LPTR *lptr;
; int offset;
;
; add signed offset to a long pointer
;
```

```
    public  lsum_
lsum_     proc      near
    extrn  lsum:near
    mov     bx,sp            ; prepare for argument load
    push    es               ; preserve caller's es
    mov     ax,4[bx]         ; get the signed offset
    mov     bx,2[bx]
    push    bx
    mov     cx,[bx]
```

```

mov     es,2[bx]
mov     bx,cs
call    lsum             ; do the signed addition
pop     ax
xchg    ax,bx
mov     [bx],ax
mov     2[bx],es        ; store the value
pop     es               ;
ret     ; exit.
lsum_   endp

```

```

;
; lcopy(dest,src,len)
; LPTR *dest;
; LPTR *src;
; long len;           (treated as a long unsigned quantity)
;
;     copy from src to dest, len bytes.
;
; note this routine can be used to copy arbitrarily large chunks of memory
;
public  lcopy_
lcopy_  proc    near
extrn   lcopy:near
mov     bx,sp           ; prepare for argument load
push    ds

```

(Continued on next page)



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Listing Five

```

push    es                ; save segment registers
push    di
push    si                ; save these registers for Aztec C
;
mov     cx,6[bx]          ; get length (low order)
mov     dx,8[bx]          ; high order of length
mov     ax,2[bx]          ; get ds:ax as pointer to dest.
xchg    ax,bx
mov     di,[bx]
mov     es,2[bx]
mov     bx,ax
mov     bx,4[bx]          ; get ds:bx as pointer for dest.
mov     si,[bx]
mov     ds,2[bx]          ; get long pointer
;
call    lcopy
;
pop     si
pop     di
pop     es
pop     ds
ret
lcopy_  endp
cseg    ends
end

```

End Listing Five

Listing Six

```

/*
env.c                                created: 25-Mar-84

This package echoes the environment to the standard output.

example of using long pointers with lsup package.

This is set-up to work with Aztec C.

by Anthony Skjellum. (C) 1984. All rights reserved.
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This program echoes the environment block to the console.
In effect, this is the same as the DOS 2.0 SET command.
Nevertheless, it illustrates the usefulness of long pointers.

-----

The following changes were made to the $begin
routine of the Aztec C 1.05i module calldos.asm:

    1) a new global variable called envseg was created

        envseg_ segment word common 'data'
        $envdat dw 0
        $envseg dw ?
        envseg_ ends

```

(Continued on page 106)

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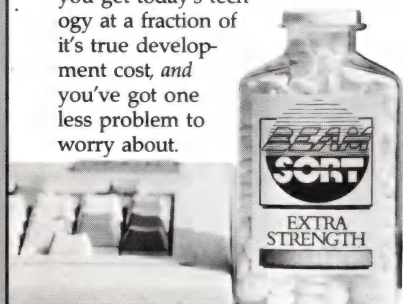
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C/UNIX

(Listing Continued, text begins on page 86)

Listing Six

- ii) On entry to \$begin, when es contains the program segment prefix (PSP), es:[2ch] contains the segment address of the environment. This segment address is stored into the second word of envseg_ (ie \$envseg).

The environment may now be referred to through the external LPTR envseg.

- iii) If DOS 2.0 allocation is to be used, be sure to shrink the program size using the SETBLOCK function. This must also be done in \$begin where the psp, ds, segments are both available.

```
*/

#include <stdio.h>
#include "lsup.h"      /* support for long pointers */

extern LPTR envseg;    /* envseg is a structure of type LPTR */

main(argc,argv)
int argc;
char *argv[];
{
    char chr;
    int i;
    LPTR lptr;

    lassign(lptr,envseg); /* get long pointer to environment */

    while(1)             /* loop */
    {

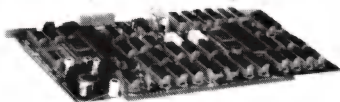
        chr = lchr(&lptr); /* get the next byte */

        if(!chr) /* we have hit the end of the environment */
            break;

        while((chr = lchr(&lptr))) /* get characters of string */
        {
            putchar(chr); /* write them to console */
            linc(&lptr); /* increment pointer */
        }

        linc(&lptr); /* pass the zero byte just encountered */
        putchar("\n"); /* add new line between entries */
    } /* end while(1) */
}
```

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by Michael Wiesenbergr

Track Zero

I knew that this year's **West Coast Computer Faire** would be hoppin' from the moment I tried to get in on Saturday. "No problem," *DDJ* editor **Renny Wiggins** had said on Thursday. "Your pass is waiting for you. I saw it myself."

It seems that *DDJ* passes can be filed under four possible names: **Doctor Dobb's Journal**, **People's Computer Company**, **M & T Publishing, Inc.**, and **Business Software** (the new sister publication). I checked all with no success.

Officials kept shunting me from one line to another, from one person with the authority to grant tickets to another. They were less than impressed with my "business card" that Renny had assured me would be my entree if all else failed: the name of the magazine, the new address, but not my name.

In desperation I called the *DDJ* booth. New editor-in-chief **Mike Swaine** came out to assist. After 15 minutes of further fruitless official shuttling and line waiting, I asked Mike, "What would **Usasi** do?" "Sneak in the side door."

Finally Renny showed up. He found my ticket misplaced among the press passes, and I was in.

The show itself was a bore. There was nothing to match last year's **Perfect Software** laser and fog spaceship, nor the numerous robots walking among the throngs.

This year the most exciting offerings were several speech synthesizers that faithfully reproduced verbally anything passers-by typed on their keyboards. Apple had a 16-foot Mac mockup, but we've seen giant screens before, particularly those with wavering, fuzzy images.

Probably the best show in town was the **Friends of Dr. Dobb's Party** that night at the **Vorpall Gallery**.

The **Vorpall Gallery**, filled with world renowned modern art, including many **Escher** originals, was a classy place for **M & T** to announce its licensing agreement with **Dr. Dobb's Journal**.

The food was excellent — piping hot meatballs in sauce, vegetables with several dips, stuffed mushrooms, puff pastries, brie — and the many varieties of wine never stopped flowing.

I asked **Timothy Leary** if he was

going to get into psychedelic software. He said that it was already here, that computers were becoming the drugs of the eighties.

I shook hands with **Robin Williams**, who was carrying a plastic shopping bag full of computer goodies and literature just like the rest of us.

Sat Tara Singh Khalsa, president of **Kriya Systems**, and devoted to the idea of programmer as superstar, held court in turban and white Sikh outfit.

Art Kleiner, editor of the **Whole Earth Software Catalog and Review**, was there, as were **Tony Bove** and **Cheryl Rhodes**, copublishers of **The Users' Guide**.

Dick Heiser, who started the first computer store ever, showed up, as did **Gordon Eubanks**, developer of **CBASIC**.

I spoke with **John Draper**, better known in his persona of the infamous **Cap'n Crunch**, phone phreak and publicizer of various rainbow-colored boxes. **Gerald Schmidt**, the undercover FBI informant who has been called "the most knowledgeable person on computer crime in the country," met Crunch face-to-face for the first time at the party.

Roger Gregory, systems anarchist, and **Ted Nelson**, both of **Project Xanadu**, floated about the canapes.

John Markoff, West Coast editor for **Byte**, and **Paul Freiburger**, who has the same position with **Popular Computing**, talked with their former associate, **David Needle**, news editor of **InfoWorld**.

Carl Helmers, the first editor of **Byte**, was seen, as were **David Ahl**, publisher of **Creative Computing** and **Sync**, and **Elizabeth Staples**, editor of **Creative Computing**.

Robert Harp, president of **Corona Systems**, wandered around.

Chris Terry, technical editor of **Microsystems**, was in evidence.

Midway through the party, **John Barry**, managing editor of **InfoWorld Books**, and **Jack Klyster**, mad inventor of the klystron tube, came in together.

While punching it down **Market Street** in my Volvo station wagon, listening to **Antonin Dvorak's New World Symphony** on the stereo, I said to myself, "I hope they give me real business cards before next year's Faire."

Punching Diskettes

The **Disk Notcher** from **Quorum** makes another write enable notch so you can use the flip side of diskettes. For Apple II+ and IIe, **Certifix** formats the new side, examines the surface, locks out flaws so they can't be used, displays and saves status report, and initializes with **DOS 3.3**. Both products cost \$29.95, with 64 write protect tabs and 32 diskette labels thrown in, or **Certifix** alone for \$24.95, and the **Disk Notcher** tool alone for \$15. Add \$1.50 p. and h., and Californians add sales tax. **Reader Service No. 101.**

A Likely Case

Anvil Cases fit most microcomputers and are virtually indestructible. They are foam-lined with aluminum exterior. Some can be customized by users for unusual configurations. In addition to the portable cases, rack-mount cases are available for heavier equipment. Anvil has been making these cases for 20 years for the music industry, to take sound systems on the road. **Reader Service No. 103.**

Dazzle Your Friends

One of the best graphics displays I saw at the Faire was produced by the **Graphics Dazzler** from **Sigma Designs**, a plug-in for the **IBM PC**, with 1024 x 1024 x 4 maximum display memory, 640 x 200 standard viewable display, 640 x 400 in "interlaced" mode. You get two display planes for four colors standard, or four display planes for 16 with the **Graphics Enhancer** stack. The board is compatible with all color and black-and-white monitors used with the PC. The display area can be panned over the 1024 x 1024 display memory, with a 1-to-16 zoom over any display area. All the work is performed by **NEC 7220** display controller software, which also has hardware line drawing, area filling, and arc drawing. There is a light pen interface, and you get graphic display software and **DOS**

boot program. The Dazzler is \$895, Enhancer \$695. The **Maximizer**, at \$395, has, in one card, 64K RAM, expandable to 384K, parallel interface for printer or bidirectional I/O, RS-232C serial interface, clock/calendar with battery backup, RAM disk, printer spooler, and, optionally, second RS-232C (\$60) and a game control adapter that supports four paddles or two joysticks (\$40). Sigma also offers various expansion cards, video cards, and hard disk subsystems that add from 10 to 33 Mb from \$1695 to \$4295. **Reader Service No. 105.**

Two More Processors for Heath/Zenith

The **H-1000**, from Technical Micro Systems, is a Z80/8086 plug-in replacement upgrade for H89/Z89 that needs no modifications. The Z80 runs at 2/4 MHz, and the 8086 at 8 MHz. The board comes with 256K RAM, expandable to 1 Mb. It has five I/O slots, and is fully compatible with all Heath/Zenith peripherals. It runs all Heath/Zenith software without modification, and is compatible with Zenith Z100 and IBM PC. You get your choice of MS-DOS or CP/M-86. TMSI seems a bit confused about its prices. The specifications brochure claims 256K RAM standard, while the price list cites the basic board *with 128K* for \$995, and *upgrade* to 256K for another \$250. Expansion to 512K is \$1695, and to 1 Mb, \$3495. They will also sell it to you as a complete system in a modified H89/Z89 case: 128K and one 100K disk drive, \$2495; 256K and one 320K drive, \$2995; or 256K and two 320K drives, \$3295. TMSI also has a lot of software for the board and computer, including Concurrent CP/M-86, MP/M-86, RAM disk utilities, accounting and communications packages, data base, languages legal, planning, spreadsheet, word processing. You can also discuss their making a custom configuration for you. **Reader Service No. 107.**

Mass Marketing Software

Paul Terrell believes that software should be vended at K-Marts, Tower Recordses, Long'ses, and 7-Elevens on reprogrammable video game cartridges. The president of **Romox** was showing off his products at the Faire, including programs for as little as \$7.95. When

you get tired of one, just bring back the cartridge, pay the clerk from \$7.95 to \$15, and get a new one. Not just games, but education, business, etc., are available now for Atari computers and 2600, Commodore 64, Vic 20, TI 99/44A, and coming soon for IBM PC, PCjr, Coleco and MSX. I saw the ROM programmer at work. You can see a list of all games and get a short preview of any game on the list. **Reader Service No. 109.**

Get GUMMed

The **Gurus of Unix Meeting of Minds (GUMM)** takes place Wednesday, April 1, 2076 (check *that* in your perpetual calendar program), 14 feet above the ground directly in front of the Milpitas Gumps. Members will grep each other by the hand (after intro), yacc a lot, smoke filtered chroots in pipes, chown with forks, use the wc (unless uclean), fseek nice zombie processes, strip, and sleep, but not, we hope, od. Three days will be devoted to discussion of the ramifications of whodo. Two seconds have been allotted for a complete rundown of all the user-friendly features of Unix. Seminars include "Everything You Know is Wrong," led by Tom Kempson, "Batman or Cat:MAN?" led by Richie Dennis, "cc C? Si! Si!" led by Kerwin Bernighan, and "Document Unix? Are You Kidding?" led by Jan Yeats. No **Reader Service No.** is necessary because all GUGUs (Gurus of Unix Group of Users) *already* know everything we could tell them.

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2	Amber Systems, Inc.	53	27	Hallock Systems Consultants	77	53	Puterparts	110
3	Ashton-Tate	3-5	28	Harvard Softworks	42	54	Quelo	47
4	Avocet Systems, Inc.	25	29	Integral Quality	51	55	Quest Research	53
5	BD Software	91	30	JV Software	107	56	Quic-N-Easi Products, Inc.	11
6	B. G. Micro	91	31	Key Solutions	35	57	Quicksoft	67
7	Bonnie Blue Software	17	32	Laboratory Microsystems	78	58	Rational Systems	85
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12	Computer Friends	72	37	MicroMethod	27	63	SemiDisk Systems	71
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14	Coriolis Company	107	39	Microprocessors Unlimited	107	65	Simpliway	107
15	Creative Solutions	69	40	MU Software	53	66	SLR Systems	95
16	C User's Group	110	41	Next Generation Systems	63	67	Softcraft	2
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78	DDJ Bound Volume	79	43	Occo, Inc.	16	69	Software Engineering Consultants	103
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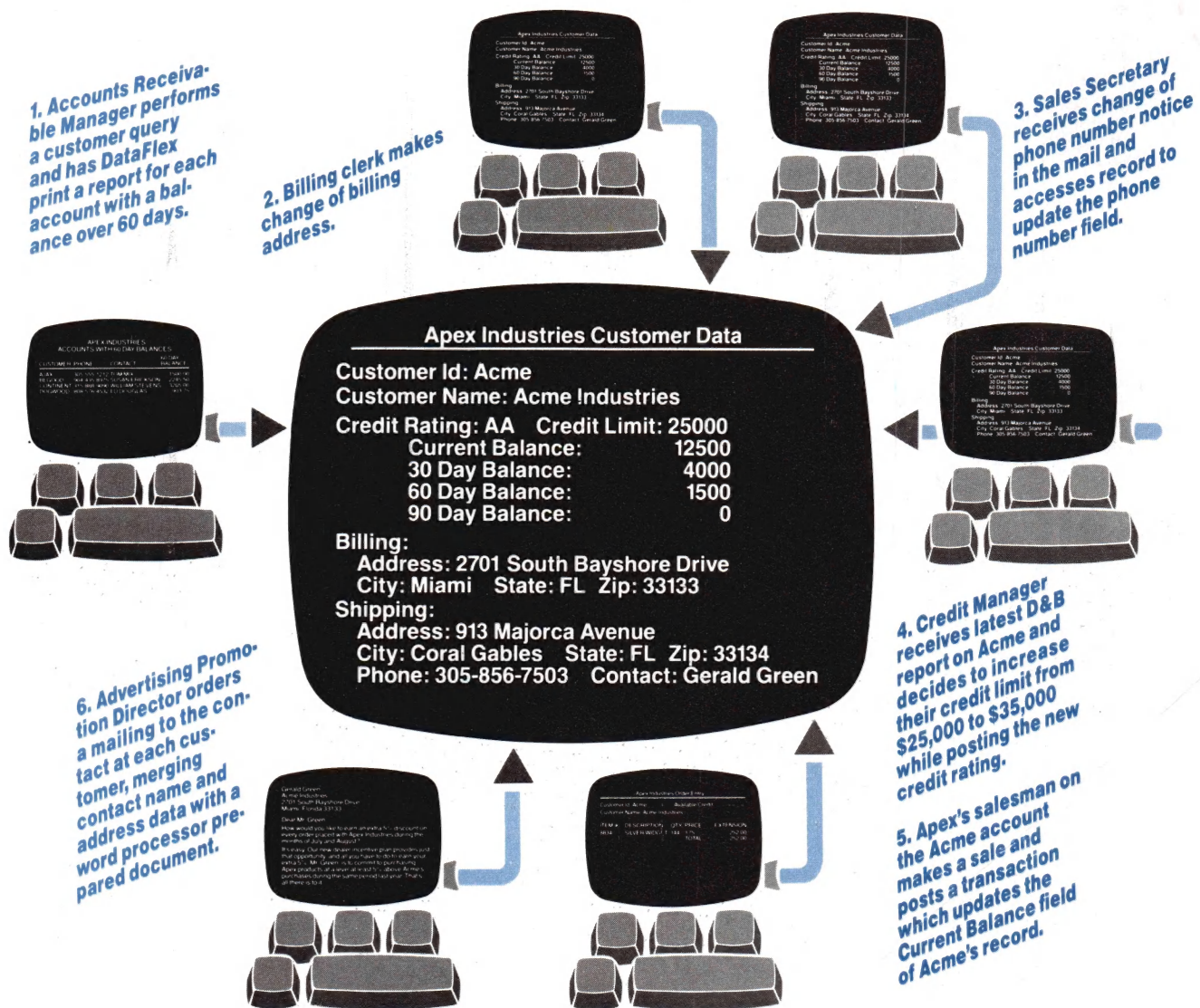
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